DEPARTMENT OF THE ARMY
NEW ENGLAND DISTRICT, CORPS OF ENGINEERS
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REPLY TO
ATTENTION OF

August 30, 2012

Engineering/Planning Division
Geo-Environmental Engineering Branch

Ms. Lynne Jennings
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Mr. Len Pinaud
Commonwealth of Massachusetts
Department of Environmental Protection – Southeast Regional Office
20 Riverside Drive
Lakeville, Massachusetts 02347

Re: Impact Area Groundwater Study Program (IAGWSP), J-3 Range Interim Environmental Monitoring Report – December 2010 through November 2011, dated August 2012

Dear Ms. Jennings and Mr. Pinaud:

On behalf of the Army National Guard's Impact Area Groundwater Study Program (IAGWSP), the U.S. Army Corps of Engineers (USACE) is pleased to provide the Final version of the subject report.

The Draft version of this document was submitted in April 2012. Comments were received from the U.S. Environmental Protection Agency (EPA) in a letter dated May 17, 2012, and from the Massachusetts Department of Environmental Protection (MassDEP) in a letter dated May 4, 2012. A Response to Comments Letter (RCL) was written on June 5, 2012. MassDEP approved the RCL in a letter dated June 12, 2012. EPA provided additional comments in a letter dated July 12, 2012. A Memorandum of Resolution was written on July 20, 2012 (included as Appendix B of the Final report). EPA approved of the MOR by e-mail dated August 1, 2012.

Please contact Dave Hill of the IAGWSP, or Mark Anderson of the USACE, if there are any questions.

Sincerely,

FOR Anthony T. Mackos, P.E.
Chief, Engineering/Planning Division

Enclosures:
EPA 1 copy and 1 CD
MassDEP 1 copy and 1 CD

Copy Furnished:
IAGWSP: Ben Gregson (letter only), Dave Hill (1 copy), and Marcia Goulet (5 copies and 2 CDs)
EPA: Jane Dolan (1 copy), Erin Sanborn (1 CD)

Impact Area Groundwater Study Program

FINAL

J-3 Range
Interim Environmental Monitoring Report
December 2010 through November 2011

Camp Edwards
Massachusetts Military Reservation
Cape Cod, Massachusetts

August 2012

Prepared for:
Army National Guard
Impact Area Groundwater Study Program
Camp Edwards, Massachusetts

Prepared by:
U.S. Army Corps of Engineers
New England District
Concord, Massachusetts

Disclaimer

This document has been prepared pursuant to government administrative orders (U.S. EPA Region I SDWA Docket No. I-97-1019 and 1-2000-0014) and is subject to approval by the U. S. Environmental Protection Agency. The opinions, findings, and conclusions expressed are those of the authors and not necessarily those of the Environmental Protection Agency.

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Acronyms and Abbreviations

3-D	three-dimensional
cf	cubic feet
COC	contaminant of concern
ETR	extraction, treatment, and reinjection
GAC	granular activated carbon
gpm	gallons per minute
HMX	octahydro-1,3,5,7-tetranitro-1,3,5,7-tetrazocine
IX	ion exchange
J	estimated value
MMR	Massachusetts Military Reservation
msl	mean sea level
MTU	modular treatment unit
ND	nondetect
RRA	rapid response action
RDX	hexahydro-1,3,5-trinitro-1,3,5-triazine
SPEIM	System Performance and Ecological Impact Monitoring Plan
TOM	top of the groundwater mound
U	non-detected value
µg/L	micrograms per liter

1.0 INTRODUCTION

This interim annual environmental monitoring report for the J-3 Range provides analyses of plume dynamics and hydraulics including assessment of model-predictions against observed behavior; monitoring program effectiveness operational aspects of the rapid response action (RRA) extraction, treatment, and reinjection (ETR) system; and the in-plant effectiveness at treating extracted groundwater. The RRA consists of a groundwater ETR system that has been operating since 26 August 2006. Results of the two groundwater sampling rounds, collected in March 2011 and again in September/October 2011, along with the results of the plant monitoring from December 2010 through November 2011, are discussed.

The J-3 Range is located adjacent to and southeast of the Massachusetts Military Reservation (MMR) Impact Area, and is the southernmost of the four former training ranges that comprise the Southeast Ranges (Figure 1-1). The Southeast Ranges are former military training ranges and defense contractor test ranges that operated from 1935 to 1997.

1.1 Purpose

The J-3 Range RRA ETI system was implemented to facilitate contaminant mass removal from groundwater and to control plume migration prior to selection of a final remedy. The purpose of this report is to document the following activities:

- Assessment of system operations;
- Assessment of the treatment system's effectiveness at removing perchlorate and hexahydro-1,3,5-trinitro-1,3,5-triazine (RDX) from groundwater;
- Evaluation of hydraulic conditions to assess aquifer response to pumping;
- Assessment of the chemical monitoring results;
- Comparison of model-predicted and observed results;
- Assessment of the effects of pumping on water levels in Snake Pond and the J-3 wetland (ecological monitoring).
- Recommendations for future monitoring activities in the plant, chemical, and/or hydraulic monitoring networks.

1.2 Background

The J-3 Range groundwater plume contains concentrations of perchlorate above the Massachusetts Maximum Contaminant Level (MMCL) of 2 micrograms per liter (µg/L) and the US Environmental Protection Agency (EPA) Lifetime Health Advisory (HA) of 15 µg/L. The plume also contains hexahydro-1,3,5-trinitro-1,3,5-triazine (RDX) above the risk-based concentration (0.6 µg/L) that results in an increase in the cancer risk calculation in excess of 10^{-6} (one in a million), the Massachusetts Contingency Plan GW-1 Standard of 1 µg/L, and the EPA Lifetime Health Advisory of 2 µg/L. The historical maximum perchlorate concentration detected in groundwater at the J-3 Range was 770 µg/L at MW-198M3 in June 2005 and the historical maximum RDX concentration was 37.6 µg/L at MW-227M2 in September 2007.

The J-3 Range ETR system was designed in 2005. At that time, the downgradient extent of perchlorate contamination was approximately 3,700 feet from the source area; RDX extended approximately 4,500 feet downgradient from the source area. The combined plumes had a maximum east-west width of approximately 1,200 feet and a maximum thickness of approximately 90 feet (ECC, 2005). The J-3 Range ETR system began full-time operation in August 2006.

Sampling described in this annual report was completed in March 2011 (semi-annual event) and again in September/October 2011 (annual event). Sampling was conducted in accordance with the Final J-3 Rapid Response Action System Performance and Ecological Impact Monitoring Plan (ECC 2006a), as revised by recommendations made in annual reports. There were no deviations from the monitoring plan during this reporting period.

2.0 J-3 RANGE PLUME TREATMENT FACILITIES AND WELLFIELD OPERATING CONDITIONS

The J-3 treatment system is located inside the existing Air Force Center for Engineering and the Environment (AFCEE) Fuel Spill-12 (FS-12) Treatment Facility at Greenway Road (Figure 2-1). System operations for the reporting period are described below.

2.1 J-3 Range Plume ETR System

The J-3 Range ETR system began full-time operation on 26 August 2006. The initial system flow rate was set at 175 gallons per minute (gpm) but was increased to the current flow rate of 195 gpm on 9 November 2007. Individual pumping rates for the three groundwater extraction wells (J3EWIP1 [100 gpm]; J3EW0032 [65 gpm]; and 90EW0001 [30 gpm]) were modified at that time, mainly to enhance capture of contaminants upgradient of extraction well J3EWIP1 (Figure 2-1).

The J-3 water treatment system is described by the process flow diagram shown on Figure 2-2. The treatment train consists of ion exchange (IX) to remove perchlorate and granular activated carbon (GAC) adsorption to remove explosives compounds (and also low concentrations of perchlorate if there is breakthrough from the IX vessels). The system is comprised of two parallel sets of three treatment vessels each: an IX unit followed by a primary and secondary GAC unit. The lead GAC vessel provides the initial stage of treatment for the removal of explosives compounds, and the secondary, or guard GAC vessel provides backup capacity, ensuring that any breakthrough of contaminants from the first two stages of treatment (IX and GAC) will be removed prior to discharge. Each ion exchange vessel contains 29 cubic feet of SIR-110-HP resin manufactured by Resin Tech, for a total of approximately 58 cubic feet. Each GAC vessel contains 1,000 pounds of virgin carbon (ACOL-GL60), for a total four-vessel capacity of 4,000 pounds.

The effluent from the treatment system is combined with the FS-12 treatment plant effluent and returned to the aquifer via the FS-12 reinjection well network located east of Snake Pond.

2.2 J-3 Range Plume ETR System Operating History

The system operated reliably with an “up time” of 93.9% during this reporting period and 94.1% since startup in August 2006. Up-time is a measure of system reliability and is defined as the number of hours the system actively treats groundwater during a given time period divided by the number of elapsed hours during the period (expressed as a percentage). During this reporting period, the J-3 Range pumps were down for 1,617 hours out of 26,280 possible pump-hours (3 pumps over a possible 8,760 elapsed hours). A summary of the downtime for the J-3 Range system for this reporting period is presented in Table 2-1. Figure 2-3 provides a graphical presentation of system availability and downtime for this period as well as for the entire period since system startup.

During this reporting period, the primary reasons for downtime were power supply interruptions of various sorts, shutdown in preparation for Hurricane Irene, and several control system faults due to telecommunication issues.

3.0 J-3 RANGE ETR SYSTEMS PERFORMANCE RESULTS

This section presents a detailed discussion of sampling history for the reporting period 1 December 2010 through 30 November 2011.

3.1 In-Plant Monitoring

The current reporting period covers the fifth year of operation. System influent and effluent samples were collected monthly and analyzed for explosives and perchlorate in accordance with the system monitoring plan (ECC, 2006a). Effluent samples from the lead IX vessels were analyzed for perchlorate; effluent samples from the lead GAC vessels were analyzed for explosives (Table 3-1).

Sampling frequencies are as follows at each of the J-3 Range MTU:

- Monthly for perchlorate and explosives at the influent (INF);
- Monthly for perchlorate at a sampling location after the ion exchange units (MID-1);
- Monthly for perchlorate at a sampling location after the lead GAC unit (MID-2) after perchlorate breakthrough of the ion exchange unit;
- Monthly for explosives at MID-2 (after the lead GAC unit), and
- Monthly for perchlorate and explosives at the effluent sample location (EFF).

All in-plant chemical sampling was conducted in accordance with the Final J-3 Range System Performance Monitoring and Evaluation Plan (ECC 2008). The sampling locations are shown in Figure 2-2. Analytical results, including COCs and field parameter measurements are presented in Table 3-2.

3.2 Operational Results

3.2.1 Influent

Analytical results for perchlorate and RDX, and other parameter measurements made during the reporting period are presented in Table 3-2.

Influent perchlorate concentrations ranged from 4.04 µg/L (11 April 2011) to 5.38 µg/L (6 December 2010) and RDX ranged from 0.335 µg/L (9 May 2011) to 0.824 µg/L (9 November 2011). Octahydro-1,3,5,7-tetranitro-1,3,5,7-tetrazocine (HMX) ranged from 0.286 µg/L (9 May 2011) to 0.708 µg/L (9 March 2011). None of the compounds, perchlorate, RDX or HMX showed discernible concentration trends over the reporting period.

Figure 3-1 presents the influent concentrations of perchlorate, RDX, and HMX measured since startup. The average influent RDX and HMX concentration values indicate a relatively steady trend since 2007. Average influent perchlorate concentrations had been increasing before this reporting period, but the upward trend is less evident during this reporting period.

Field parameters (dissolved oxygen, pH, specific conductivity, temperature, oxidation-reduction potential, and turbidity) were collected from the influent and effluent concurrently with all sampling events. These data were all within normal limits. No other geochemical parameters were measured during this sampling period. The sampling schedule for this reporting period is presented in Table 3-1.

3.2.2 Breakthrough of Contaminants of Concern

Breakthrough is defined as any concentration of explosives or perchlorate detected in effluent from a treatment vessel at or above an action level of 0.25 µg/L (RDX) or 0.35 µg/L (perchlorate). The trigger for an IX resin exchange is breakthrough of perchlorate from the lead IX vessel, as measured in the J3-MID-1 sample; the trigger for a GAC change out is breakthrough of explosives from the lead GAC vessel, as measured at the MID-2 sample port (i.e., as measured in sample J3-MID-2) (Figure 2-2).

No RDX or HMX breakthrough was detected during this reporting period. Perchlorate was measured at the action level of 0.35 µg/L in the J3-MID-1 sample on 8 August 2011 and again on 8 September 2011. An IX media exchange took place on 19-20 September 2011.

3.2.3 Total Groundwater Volume Treated

For the reporting period, the total volume of groundwater that was extracted, treated, and re-injected by the J-3 Range ETR system was 96 million gallons. Since its startup in August 2006, a total of 487 million gallons of groundwater has been processed by the J-3 ETR system (Figure 3-2).

3.2.4 Mass Removals

The method for calculating mass removal is the chemical concentration (C) multiplied by system flow rate (Q) multiplied by time of operation (T). Time of operation is affected by amount of system down time (Table 2-1). Figure 3-1 provides the influent concentrations (C) on a monthly basis. Figure 3-2 provides the influent volume treated (Q * T), and Figure 3-3 provides the mass removed on a monthly basis (C*Q*T). The operating parameters of the ETR system are tracked on an ongoing basis by the operations contractor. All data necessary to verify mass removed can be deduced from these figures.

Based on the quantity of groundwater treated and influent concentrations measured during the reporting period, the J-3 Range ETR system removed approximately 3.76 pounds of perchlorate, 0.46 pounds of RDX, and 0.38 pounds of HMX from the J-3 Range plume. For comparison, modeled estimates of mass removed from the J-3 plume are discussed in Section 6.0. Since startup in August 2006, the J-3 Range ETR system has removed a total of approximately 13.4 pounds of perchlorate, 2.7 pounds of RDX, and 1.2 pounds of HMX (Figure 3-3).

3.2.5 Sampling Frequency Evaluation

The monthly sampling described in Section 3.1 has been adequate to monitor for filter media breakthrough and to ensure that the plant effluent meets the discharge requirements.

4.0 HYDRAULIC PERFORMANCE MONITORING

A hydraulic monitoring synoptic event was conducted for the J-3 Range plume on 21 September 2011, the purpose of which was to evaluate system performance through analysis of the aquifer's hydraulic response to system operations. All water levels are referred to relative to mean-sea-level (msl), which corresponds to the zero elevation of the NGVD29 datum.

4.1 Synoptic Water Level Measurements

The 2011 synoptic event was conducted to help determine changes in groundwater and flow patterns in the vicinity of the J-3 Range ETR system. During the evaluation, each of the three extraction wells was operating at their design rates and water level measurements were collected at nearly all wells specified in the J-3 Range system performance monitoring plan (ECC 2008) with the exceptions being wells in the immediate vicinity of Snake Pond that were submerged during at the time of the sampling. The hydraulic monitoring network is shown in Figure 4-1. Table 4-1 lists the water level monitoring network, Table 4-2 presents water level data collected on 21 September 2011 with observed changes, and Table 4-3 evaluates vertical hydraulic gradients.

4.2 J-3 Range Groundwater Level Analysis

The water levels measured on 21 September 2011 were analyzed for potential data anomalies and errors. The water level measurements obtained from several wells including MW-217M1/M3/M4 and MW-251M1/M2/M3 are all located along the Snake Pond shoreline were submerged and water levels could not be measured. Also, the water levels reported for the MW-227 well cluster were anomalously high suggesting a J3EWIP1 stagnation zone that is much farther downgradient than anticipated and, as such, the well is being recommended for re-surveying. Otherwise, no problems were reported with any of the other monitoring points.

The water level data from the 21 September 2011 event ranged from 71.49 feet msl at 90MW0010 in the southern end of the study area to 73.87 feet msl at MW-128M2 in the northern end of the monitoring network (Figure 4-1). The horizontal gradient calculated across the J-3 Range for the 21 September 2011 synoptic event was approximately 0.00059 feet/foot.

The water level data from monitoring wells with screen mid-points from +40.71 to -77.67 feet msl were used to construct a groundwater potentiometric map (Figure 4-2). These wells are screened at a similar elevation to the extraction wells which are screened from +5.06 to –67.08 ft msl. The potentiometric analyses were aided by using SURFER (Version 9), a geo-mapping software package. Monitoring wells bolded in Figure 4-2 indicate the wells used to develop the potentiometric surface map. The other data collected in the cluster are used to assess vertical gradients.

As shown in Figure 4-2, the regional groundwater flow direction, based on water level measurements, at the interval from +40.71 to -77.67 feet msl, is from north to south with

convergent flow near the three extraction wells, due to the hydraulic stress of pumping. Groundwater flow in the upgradient area is toward the south, until just north of the J3EWIP1 well. At this point, flow to a distance of about 300 feet east and west of J3EWIP1 begin to converge on the extraction well. The downgradient stagnation point of the J3EWIP1 extraction well lies north of MW-227 wells. Groundwater downgradient of the MW-227 wells continues to move southward and converges on either well J3EW0032 or 90EW0001. Based on an interpretation of hydraulic measurements, groundwater appears to be generally flowing toward the extraction wells at plume elevation.

An evaluation of the water levels measured on 21 September 2011 (Table 4-3), at individual wells within well clusters, generally indicates that vertical gradients are similar in magnitude and direction as in 2010. Also, the upward gradients generally occur in the deeper paired well screens. The largest upward gradient (0.0089 ft/ft) is at the MW-343 M1/M2 wells, which is assumed to be a result of pumping at the J3EWIP1 extraction well. The largest downward gradient (-0.0161 ft/ft) is at the MW-157 well cluster, which does not make as much intuitive sense but suggests vertical capture in this area. The same downward gradient is true at the MW-198 well cluster, located to the north of the J3EWIP1 extraction well, where vertical capture is demonstrated. Elsewhere around the site, calculated vertical gradients are very small and do not indicate a clear upward or downward vertical gradient, with the exception of a noticeable downward gradient at the MW-157 well cluster near the wetland east of the J3EWIP1 extraction well. While the surface water elevation at the wetland piezometer (ECPZJ3W001) is substantially higher than the surrounding groundwater, the downward gradient in this area suggests leakage and the development of a minor groundwater mound in this area that would tend to force contaminated groundwater to the west as it moved past this area from north to south.

4.3 Regional Groundwater Level Changes

The 21 September 2011 water level data were analyzed and compared with the earlier synoptic water level measurements made under operational conditions to evaluate long-term changes in water levels and identify trends (Table 4-2). The change in groundwater level between 10 October 2010 and 21 September 2011 ranged from -1.13 to -0.32 feet and averaged -0.83 feet.

These decreases in water levels are consistent with regional decreases in water levels for this same time frame, as measured at several USGS monitoring wells, where water level measurements are recorded every 15 minutes by a pressure transducer data logging system. The four USGS wells including 90MW0063, MW-145S, 537-0107 and MW-126S indicated a decrease of 0.97 feet, 0.85 feet, 1.13 feet and 1.46 feet, respectively, during this period from 25 October 2010 to 21 September 2011. This data is available on the USGS websites:

- http://waterdata.usgs.gov/nwis/dv/?site_no=414124070311401&agency_cd=USGS&referred_module=gw
- http://waterdata.usgs.gov/nwis/dv/?site_no=414139070311501&agency_cd=USGS&referred_module=gw

- http://waterdata.usgs.gov/nwis/dv/?site_no=414159070310501&agency_cd=USGS&referred_module=gw

- http://waterdata.usgs.gov/nwis/dv/?site_no=414219070313601&agency_cd=USGS&referred_module=gw

The four USGS wells provide a detailed history of groundwater levels near the top of the regional groundwater mound. The USGS wells are superior to using J-3 Range monitoring wells because of their long data history and because the frequency of data collected at the USGS wells is once every 15 minutes while the water levels at the J-3 Range wells are only measured just a few times per year.

5.0 CHEMICAL MONITORING

An annual chemical sampling event was conducted in September/October 2011, and a semi-annual event was conducted in March 2011. The current chemical monitoring network is presented in Table 5-1 and sample results are presented in Table 5-2. Figure 5-1 depicts the plan view of the wells in the perchlorate sampling plan along with the plume and line of cross-section. Figure 5-2 depicts perchlorate concentrations along the cross-section. Figure 5-3 depicts the perchlorate plume with graphs of historical perchlorate concentrations at selected wells.

Figure 5-4 depicts the explosives sampling network with the RDX plume and the line of cross-section and Figure 5-5 depicts RDX concentrations along the cross-section. Figure 5-6 depicts the RDX plume with graphs of historical RDX concentrations at selected wells.

Sample collection, and field monitoring equipment calibration and maintenance, was conducted in accordance with approved procedures (ECC 2005).

5.1 Monitoring Results

The two primary site related contaminants in the J-3 Range plume are perchlorate and RDX. Although there is a high degree of commingling of the perchlorate and RDX contamination within the J-3 Range plume, there is some variability in the mass distribution of perchlorate and RDX within the plume. This is largely due to the fact that the plume resulted from releases at the J-3 Range over a time frame spanning several decades. Monitoring results were used to develop interpretations of current plume size and shape; however, it is important to consider that the spatially limited monitoring well data requires that concentrations be forward migrated in order to fill in areas without monitoring wells and therefore some at the highest concentrations may be interpreted in areas without recently measured data.

The representation of concentrations and contaminant distributions shown in the figures and discussed in this section were developed conservatively using both profile data and fixed well data collected over time, and in consideration of the groundwater flow trajectories inferred from the groundwater elevation contours that have been mapped within the study area. The geology depicted on the cross sections was based on available drilling information and professional judgment.

5.1.1 Perchlorate

The J-3 Range perchlorate plume, as defined by the MMCL of 2 µg/L, begins in the vicinity of the former J-3 Demolition Area, and extends approximately 3,500 feet south to the northwestern shoreline of Snake Pond. The plume has a current maximum width of approximately 475 feet (Figure 5-1) and thickness of approximately 80 feet (Figure 5-2). The plume orientation at its trailing edge is southerly, but shifts to a southeasterly direction in the approximate area of the installation boundary as it tracks toward Snake Pond. For ease of discussion, the plume has been divided into the following segments: (1) trailing edge, (2) plume core upgradient of the

base boundary, (3) plume core downgradient of the base boundary, and (4) the leading edge. Concentration trends for perchlorate in select wells are provided in Figure 5-3 to supplement the discussions that follow.

Perchlorate Plume Trailing Edge

Results for MW-163S, which are representative of the current source area contribution, show a significant and continued decrease in concentration over time, with the most recent (October 2011) results being 1.57 µg/L (Table 5-2), which is slightly higher than the previous concentration of 0.19 µg/L, measured in October 2010, but significantly less than the highest concentration of 120 µg/L, measured in March 2005 . This trend suggests that the 2004 soil rapid response action at the J-3 Range has successfully mitigated the release of perchlorate in the source area. There currently is no groundwater data within the plume immediately downgradient of MW-163S.

Downgradient bounding wells, including MW-232M1, MW-232M2, MW-193M1, MW-193S, MW-243M1, and MW-243M2 (Figure 5-1), all continue to exhibit concentrations below the 2 µg/L threshold.

Perchlorate Plume Core Upgradient of Base Boundary

The plume core, upgradient of the base boundary, contains the highest concentrations of residual perchlorate detected within the J-3 Range plume. The cross-section shown in Figure 5-2 is drawn parallel to groundwater flow along the axis of the plume (Figure 5-1) and through wells exhibiting the highest historical perchlorate concentrations.

During the current sampling period, the deepest well at the MW-198 cluster (M1), again exhibited very low detection (0.013J µg/L) of perchlorate. The remaining three wells in the MW-198 cluster each have shown substantial reductions of perchlorate since 2006 and 2007. Concentrations, at that time, measured in the hundreds of micrograms per liter. Current concentrations (those reported in 2011) have declined to single digit values with 2.5 µg/L in the M2 well, 2.43 µg/L in the M3 well, and 8.44 µg/L in the M4 well during the most recent sampling round (Table 5-2). This is likely because the elevated perchlorate concentrations in the plume core have migrated downgradient beyond the MW-198 well cluster. Wells flanking the plume, east and west of the MW-198 cluster, including MW-197M2, MW-197M3, MW-295M1, MW-295M2, MW-359M2, and MW-144M2 (Figure 5-1), all show continued perchlorate concentrations below the 2.0 µg/L MMCL.

Further downgradient and nearer the installation boundary, wells in cluster MW-143, MW-343, and MW-227 showed concentrations slightly higher than upgradient wells (Figure 5-1). Detections above the 2 µg/L standard in this region of the plume were observed in MW-227M2 (2.06 µg/L), MW-343M1 (3.14 µg/L), and extraction well J3EWIP1 (8.88 µg/L). Based on interpreted water table contours and flow paths from the September 2011 water level survey (Figure 4-2), perchlorate detected in well MW-143 is being captured by extraction well J3EWIP1. This was corroborated in the 2010 J-3 EMR when numerical modeling indicated that

under average water table conditions contamination at the MW-143 well cluster would be captured but under high water table conditions capture may not be fully achieved.

Elevated perchlorate concentrations originally detected upgradient at the MW-198 well cluster in 2004 and 2005 are expected to eventually be captured by J3EWIP1 as well. The travel time from the monitoring wells in the MW-198 well cluster o the J3EWIP1 extraction well is predicted to be approximately 100 years for MW-198M1, 12 years for MW-198M2, and 5 years for both MW-198M3 and MW-198M4. The relatively short travel time for the shallow monitoring wells is due to the relatively high hydraulic conductivity in sediments at an elevation greater than approximately -30 ft msl and the increased travel times from deeper monitoring wells MW-198M2 and especially MW-198M1 reflect the much lower hydraulic conductivity in sediments deeper than -30 ft msl. Last year's perchlorate increase observed in nearby MW-343M2 (Figure 5-3) suggests that this contaminant slug may now be starting to enter the well. Because of the possible dilution effect produced by mixing over the 40-foot screen length in J3EWIP1, concentrations entering the base of this screen (Figure 5-2) may well be greater than the measured 8.88 µg/L. Concentrations in wells located west of J3EWIP1 (J3-MW-1-B, and J3-MW-1-C) were below 2.0 µg/L, indicating that the plume is adequately bounded in the western vicinity of the extraction well. Concentrations in the well east of J3EWIP1 (MW-142M2) was 6.31 µg/L, which is an increase from the 2010 result but is consistent with previous concentrations measured at this well and was significantly less than the maximum concentration of 37.3J µg/L measured in September 2007. Previous groundwater modeling described in the 2010 EMR (IAGWSP, 2011) indicates that contamination at monitoring well MW-142M2 is likely captured [this determination will be aided by information gained in the recommended drive-point program].

Downgradient of J3EWIP1, near the installation boundary, the perchlorate plume is similarly well defined vertically by the 2.06 µg/L concentration detected in MW-227M2 (Table 5-2) and trace concentrations detected in the M3 and M1 screens located above and below, respectively (Figure 5-2). Concentrations observed in the MW-157 and MW-155 clusters located to the east and west bound the perchlorate plume laterally in this region as well (Figure 5-1).

Perchlorate Plume Core Downgradient of Base Boundary

Perchlorate concentrations, downgradient of the installation boundary, are generally lower than those reported in the northern portions of the plume. In 2011, none of the wells of the MW-247 well cluster, and the MW-250 well cluster, had a detection of perchlorate exceeding the 2.0 µg/L Massachusetts MMCL standard (Table 5-2). Though perchlorate concentrations in extraction wells J3EW0032 and 90EW0001 were below the 2.0 µg/L standard, it is assumed that some of the groundwater captured by these wells enters at a higher concentration due to the long screen lengths (Figure 5-2). Wells within the MW-247 and MW-329 clusters continue to define the western limit of the plume in the vicinity of these extraction wells with concentrations below 2.0 µg/L and the MW-157 cluster continues to define the eastern limit of the plume with similarly low concentrations (Figure 5-1).

Perchlorate Plume Leading Edge

Due to elevated surface water levels at Snake Pond, leading edge samples were obtainable only from well 90PZ0204. The remaining sampling points (MW-171M2, MW-217M2, MW-217M3, MW-218M3, and MW-251M1) were submerged during 2011 monitoring period. Perchlorate was detected at 90PZ0204 at a concentration of 0.115 µg/L. Measurements at 90MW0104B and 90MW0104C are scheduled to be collected bi-annually and will be collected in October 2012, if feasible. Of the five un-sampled wells, referred to above, only wells MW-217M2 and MW-251M1 have exhibited detectable concentrations of perchlorate in the past, but all have been consistently below 2 µg/L. Monitoring well 90PZ0211 is located approximately 200 feet upgradient of Snake Pond and was sampled in 2011, having a concentration below 2 µg/L.

5.1.2 RDX

Like the perchlorate plume, the RDX release likely originated at the J-3 Demolition area of the site. Once in groundwater, RDX migrated south with groundwater flow, toward the base boundary, ultimately turning southeast toward Snake Pond (Figure 5-4). The resulting RDX plume, which is currently defined by the 0.6 µg/L EPA risk-based concentration, is comprised of a series of discontinuous lobes extending approximately 3,500 feet from the source area to the northern shore of Snake Pond. It is approximately 300 feet wide at its widest point normal to groundwater flow (Figure 5-4), and approximately 30 feet thick at its greatest vertical extent (Figure 5-5). For discussion purposes, the plume is divided into the following three segments: (1) trailing edge, (2) plume at and downgradient of base boundary, and (3) leading edge. RDX concentration trends in select wells are provided in Figure 5-6 to supplement the text discussions below.

RDX Plume Trailing Edge

The trailing edge consists of two discontinuous lobes extending from the source area near MW-163S to the first extraction well J3EWIP1 (Figure 5-4). Similar to perchlorate, there has been overall decreasing trend in RDX concentrations in well MW-163S beginning in 2005 (Figure 5-6) suggesting that the soil rapid response action performed at the site in 2004 has effectively eliminated any further loading of RDX contamination at the source.

The first RDX lobe continues to be bounded by results from MW-232M1 to the west, and MW-193S, MW-193M1, MW-197M2, and MW-197M3 to the east. The highest concentration among samples collected from these five wells in 2011 was the 0.269 µg/L value reported in MW-197M3. The downgradient extent of this lobe is defined by non-detects reported in MW-198M1, M2, and M3 (Figure 5-6). Results over the past few years suggest that the isolated RDX detection observed in the upper M4 screen (1.28 µg/L) is not indicative of a trend, and possibly a transient residual associated with past elevated concentrations measured in this well. Future results will be used to confirm that it is not indicative of a new trend for this well.

The second lobe begins downgradient of MW-198M2 and extends to extraction well J3EWIP1 where RDX concentrations in 2011 measured 0.65 µg/L (Figure 5-4). The non-detect RDX concentrations measured in MW-343M1 and MW-343M2 indicate that this lobe is well defined vertically in the vicinity of J3EWIP1 (Figure 5-5). Similar non-detections in MW-143 (M1, M2,

and M3) and MW-142 to the east, and J3-MW-1-B and J3-MW-1-C to the southwest suggest the plume limits are well defined in this area (Table 5-2).

RDX Plume at and Downgradient of Base Boundary

One major and two minor RDX plume lobes exist between the installation boundary and the downgradient region just north of Snake Pond. The major (larger) lobe, which likely contains the highest concentrations of RDX contamination, begins between well J3EWIP1 and monitoring well MW-227M2. RDX concentrations reported in MW-227M2 (5.22 µg/L), MW-250M2 (0.204 µg/L) and extraction well J3EW0032 (0.848 µg/L) define the north-south extent of the lobe (Figure 5-6). Non-detections in wells flanking to the east (well cluster MW-157) and west (MW-155M1 and well cluster MW-247) define its lateral extent. Similarly, the absence of RDX in wells MW-227M3 and MW-227M1 above and below define the vertical limits of the lobe (Figure 5-5).

The remaining two smaller RDX lobes, which are located in close proximity to, but downgradient of the extraction wells J3EW00032 and 90EW0001, are characterized by lesser concentrations of RDX. Due to their limited extent, neither of these lobes is intersected by an existing well. Thus, the configurations depicted on Figures 5-4 and 5-5 can only be inferred from past detections at 90PZ0211 and cluster MW-217, and local groundwater flow characteristics. Modeling indicates that both of these lobes will continue to attenuate.

RDX Plume Leading Edge

In the absence of available data from MW-171M2, MW-217M2, MW-217M3, MW-218M3 and MW-251M1, due to well access limitations, the leading edge of the RDX plume cannot currently be defined with confidence. However, past trace concentrations in MW-171M2 and non-detects in MW-217M2, MW-217M3, MW-218M3, and MW-251M1, along with non-detects in samples collected from 90PZ0204 and 90PZ0211 in 2011 (Figure 5-6), suggest the plume may no longer extend beneath Snake Pond and terminates in the vicinity of 90PZ0211 (Figure 5-5).

5.1.3 Other Explosives

In addition to perchlorate and RDX, HMX was detected in ten samples collected from each of ten monitoring wells. The EPA health advisory for HMX is 400 µg/L and the MCP GW-1 criteria is 200 µg/L. The maximum concentration detected was 3.2 µg/L at MW-197M3. The only other explosives compound detected in the groundwater samples was 4-Amino-2,6-Dinitrotoluene at a concentration of 0.19J µg/L and also at monitoring well MW-193M3 (Table 5-2). The Regional Screening Level for 4-Amino-2,6-Dinitrotoluene in tap water is 0.3 µg/L.

6.0 GROUNDWATER MODELING

Various modeling tools were used to evaluate the performance of the J-3 Range ETR system and the J-3 Range plume. Modeling-predictions from the revised perchlorate and RDX plume shells, developed with data through September 2007 (model date 2007.75), were compared to recently observed concentrations at monitoring wells, influent concentrations, and mass removal to assess the reliability of the 2007.75 plume shell and to identify potential areas for optimization. As indicated in the following sections, the relatively poor comparison between measured and predicted perchlorate and RDX concentrations at monitoring wells and extraction wells has necessitated the collection of additional groundwater quality data through a drive point program. The program was proposed in a project note that was approved by the EPA and MADEP on 26 January 2012 and the data will be used to refine the current understanding of the perchlorate and RDX plumes and to support the development of revised perchlorate and RDX plume shells.

The flow model, used to support the perchlorate and RDX simulations, represents "average" flow field conditions based on historic data and simulated during the 2003 development of the J-3 Range model used for the RRA. The only change made to the flow model from year-to-year is an update of the MODFLOW well file, so that the pumping stress applied to the model is accurate. Therefore, it is expected that from one year to the next the flow model will either over or under predict measured conditions, but in the long term the coupled flow and transport model will provide reliable predictions of perchlorate and RDX, provided that the plume shell is adequately maintained to reflect the measured conditions.

6.1 Model Predictions versus Observed Concentrations

Groundwater modeling activities conducted for this report primarily consisted of additional post-processing of more recent model simulations developed for the 2007 J-3 Annual Report (ECC, 2008). No attempt was made to develop any new plume shells for perchlorate and RDX. Model-predicted concentrations in individual monitoring wells were generated to compare to observed values.

Model-predicted mass capture for individual extraction wells were compared to observed values based on influent concentrations. These evaluations were conducted to 1) evaluate the appropriateness of the contaminant distributions in the 2007.75 (1 October 2007) RDX and perchlorate plume shells, 2) identify areas where the model-predicted and observed concentration trends could be used to either help confirm cleanup due to system operation or highlight potential problem areas that may not have been included in the contaminant plume shells, and 3) identify potential opportunities to optimize system flow rates either now or in the near future. The comparison of measured and predicted perchlorate plumes and measured and predicted RDX plumes is illustrated in Figure 6-1 and Figure 6-2, respectively.

The flow model, being used to support the perchlorate and RDX simulations, represents "average" flow field conditions based on historic data and simulated during the development of the RI/FS for the J3 Range. The only change to the flow model that is made from year-to-year is

an update of the well file so that the pumping stress applied to the model is accurate. Therefore, it is expected that from one year to the next the flow model will either over or under predict measured conditions but in the long term the coupled flow and transport model will provide reliable predictions of perchlorate and RDX, provided that the plume shell is regularly updated to reflect the measured conditions. Comparisons of measured and predicted perchlorate and RDX concentrations are summarized in Tables 6-1 and 6-2.

6.1.1 Perchlorate

For the perchlorate concentrations along the western edge of the plume, upgradient of extraction well J3EWIP1, there is moderately good agreement between observed and model-predicted concentrations at MW-163S, MW-232M1 and MW-295M1 (Figure 6-1). The model predicted a concentration of 0.058 µg/L, versus a measured concentration of 1.57 µg/L, in October 2011 at MW-163S; however, this may be because the model did not simulate a continuing source. Similarly, at MW-232M1 the model predicted a concentration of 1.35 µg/L, compared to a measured concentration of 0.915 µg/L, in October 2011. Lastly, at MW-295M1, the model predicted a concentration of 0.511 µg/L, versus a measured concentration of 0.594 µg/L, in October 2011. Model predicted concentrations along the centerline of the plume are similar at MW-198M4 and MW-198M2, where concentrations measured 8.4 µg/L and 2.46 µg/L compared to model predicted concentrations of 12.7 µg/L and 10.2 µg/L, respectively. The model significantly over-predicted concentrations in MW-198M3. Measured concentrations in this well dropped significantly from 120 µg/L in August 2008 to 7.45 µg/L in September 2009 and then to 2.43 µg/L in September 2011, but the model predicts a concentration of approximately 52.1 µg/L in October 2011.

Concentration values in the eastern edge of the plume at MW-193S, MW-197M2, and MW-143M3/M2 were compared to model predicted concentrations (Figure 6-1). Measured concentrations in MW-193S (0.066 µg/L) were consistent with the model predicted non-detect. Measured concentrations in MW-197M3 were 0.11 µg/L, which is comparable to the model predicted concentration of 0.589 µg/L. However, at depth (MW-197M2) the model over-predicts the measured concentration (5.5 µg/L vs. 0.393 µg/L, respectively). Concentrations further downgradient in wells MW-143M3/M2 were over-predicted by the model. The model predicted 24.2 µg/L in MW-143M2 and the measured concentration was 1.44 µg/L. Similarly, in MW-142M2, located further downgradient, the model predicted 9.91 µg/L, versus a measured concentration of 6.31 µg/L (September 2011).

Between J3EWIP1 and the two downgradient extraction wells, J3EW0032 and 90EW0001, the model slightly under-predicted concentrations at wells MW-227M2, MW-250M2 and MW-247M2 (Figure 6-1). At MW-227M2, the model predicted a concentration of 0.747 µg/L compared to a measured concentration of 2.06 µg/L (September 2011). At MW-250M2, the model predicted a concentration of 0.003 µg/L compared to a measured value of 1.64 µg/L, and at MW-247M2 the model predicted a concentration of 0.639 µg/L compared to a measured value of 0.567 µg/L.

Similarly, this trend was noted at the two downgradient extraction wells, J3EW0032 and 90EW0001, where the model predicted influent concentrations of 0.617 µg/L and 0.380 µg/L

compared to measured influent concentrations of 0.815 µg/L and 0.616 µg/L, respectively (Figure 6-1). Concentrations in 90PZ0211, located south of the southern extraction wells, measured 0.081 µg/L (September 2011) in comparison to a model predicted concentration of 0.107 µg/L.

The recently observed perchlorate plume is somewhat similar to the model predicted plume, having approximately the same length but is significantly thinner than the model predicted plume over most of its length (Figure 6-1). The most upgradient portion of the perchlorate plume at the source area is predicted to have lower peak concentrations than the measured plume, but these concentrations in the measured plume are from forward migrated upgradient concentrations and have not been confirmed. The downgradient extent of the perchlorate plume is predicted to be slightly less than the measured plume. A drive point program is being implemented in 2012 to re-acquire the elevation of the plume core, which is currently based solely on forward migrated data.

6.1.2 RDX

For the RDX plume, concentrations in monitoring wells, within and near the source area, MW-163S, MW-193S and MW-232M1, were evaluated to determine if the plume shell in this upgradient portion of the plume is consistent with measured values (Figure 6-2). At MW-163S, the model currently underestimates RDX concentrations at the source area, as a result of residual mass still being transported through the vadose zone. Concentrations were measured to be 1.54 µg/L in October 2011, compared to a simulated concentration of approximately 0.011 µg/L.

Monitoring wells MW-193S and MW-232M1 were evaluated to determine if the plume shell in this upgradient portion of the plume is consistent with measured values. The model is fairly accurate in the vicinity of MW-193S, where model predicted and measured concentrations were non-detect. The model over-predicts concentrations in proximity to MW-232M1, where the concentration was non-detect in October 2011, but the model simulates concentrations of approximately 1.79 µg/L. Model predicted upgradient concentrations accurately predict the concentration in well MW-198M4 (0.943 µg/L versus 1.28 µg/L measured). At depth, the model slightly over-predicts the non-detect measured concentrations in MW-198M3/M2, yielding approximately 2.04 µg/L and 0.868 µg/L, respectively. At the in-plume extraction well (J3EWIP1), the model simulated influent concentrations (measured 0.65 µg/L versus modeled 0.46 µg/L in March 2011 and measured 0.47 µg/L versus modeled 0.37 µg/L in September 2011) reliably. Similarly, the model simulated concentrations in monitoring well MW-343M2, located adjacent to the in-plume well (0.279 µg/L simulated versus 0.222UJ µg/L measured) reasonably well. Downgradient of extraction well J3EWIP1, observed concentrations in monitoring well MW-227M2, decreased from 38.2 µg/L in 2008 to 20.7 µg/L in 2009 to 6.55 µg/L in 2010 to 5.22 µg/L in October 2011. Model-predicted concentrations for 2011 were simulated at 3.77 µg/L. Monitoring wells MW-247M2 and MW-250M3/M2 are located near the periphery of the plume and closer to the two downgradient extraction wells J3EW0032 and 90EW0001. Concentrations in MW-247M2 measured as non-detect in October 2011, which is similar to the model predicted concentration of 0.521 µg/L. The model over-predicts concentrations at MW-

250M3 (4.07 µg/L versus a measured non-detect), and under-predicts concentrations in MW-250M2 (0.894 µg/L versus a model predicted non-detect). Both wells are within the horizontal and vertical capture zone of J3EW0032. Influent concentrations at 90EW0001 were non-detect in September 2011, compared to a simulated concentration of 0.143 µg/L. Influent concentrations measured at J3EW0032 measured 0.848 µg/L in September 2011, versus a model simulated concentration of 1.57 µg/L. RDX concentrations in the two small lobes downgradient of the J3EW0032 and 90EW0001 extractions wells is predicted to be slightly greater than 0.6 µg/L currently and to less than 0.6 µg/L by 2013.

The observed RDX plume is somewhat similar to the model predicted (Figure 6-2), however, the predicted concentrations are higher than measured at the upgradient portion of the plume and lower than measured at the downgradient portion of the plume. Overall though, the width of the predicted plume is greater and displays less segmentation than the measured plume.

6.2 J-3 Range Plume ETR System Capture

Results from the 2007.75 plume shell were compared to observed mass capture for the J-3 Range ETR system. In addition, modeled influent concentrations for individual extraction wells were compared to observed concentrations to evaluate the accuracy of the plume shells and identify potential opportunities for system optimization. Observed mass capture was calculated for both the treatment plant and extraction wells. Mass capture at the treatment plant was calculated based on observed influent concentrations and flow rates as described in Section 3.0. Mass capture at extraction wells was calculated based on measured concentrations and flow rates at the wells. The capture zone at an alternate water elevation was addressed in the 2010 annual report (USACE 2011) to alleviate the concern that the average flow condition used in the model would tend to over-estimate the size of the capture zone under high water table conditions.

6.2.1 Perchlorate Removal by Extraction Wells

Influent perchlorate concentrations at the J-3 Range plume extraction wells are measured monthly at the treatment systems. Figure 6-3 presents the measured influent concentrations (prior to treatment) compared to model predicted influent concentrations for 90EW0001. As indicated in Figure 6-3, predicted perchlorate concentrations at 90EW0001 are less than measured concentrations by approximately 0.4 µg/L. During the reporting period, model predicted concentrations range from approximately 0.2 to 0.4 µg/L and measured concentrations range from approximately 0.62 to 0.64 µg/L.

At J2EW0032 (Figure 6-4), model predicted influent perchlorate concentrations were consistently under-predicted by approximately 0.24 to 0.29 µg/L. Measured concentrations decreased from approximately 0.84 µg/L, near the start of the reporting period, to approximately 0.82 µg/L, near the end of the period. Predicted concentrations increased from approximately 0.51 µg/L, at the start of the reporting period, to approximately 0.63 µg/L, at the end of the period.

At J3EWIP1 (Figure 6-5), model predicted influent perchlorate concentrations were consistently over-predicted by approximately 4.78 to 5.49 µg/L. Measured concentrations decreased from approximately 8.08 µg/L, near the start of the reporting period, to approximately 8.99 µg/L, near the end of the period. Predicted concentrations increased from approximately 13.34 µg/L, at the start of the reporting period, to approximately 13.65 µg/L, at the end of the period.

The perchlorate mass removal for the system determined at the treatment plant during the reporting period (01 December 2010 through 30 November 2011) was 3.76 pounds compared to a model predicted mass removal of 6.11 pounds (Figure 6-6).

6.2.2 RDX Removal by Extraction Wells

Similar to perchlorate, the transport model indicates the predicted performance of the system, with respect to RDX, is similar to the system basis of design. Extraction wells 90EW0001, J3EW0032, and J3EWIP1 effectively capture upgradient and cross-gradient portions of the plume.

Influent RDX concentrations at the J-3 Range plume extraction wells are measured monthly at the treatment systems. Figure 6-3 presents the measured influent concentrations (prior to treatment) compared to model predicted influent concentrations at 90EW0001. At 90EW0001 (Figure 6-3), model predicted concentrations are very similar to measured concentrations and both are approximately 0.2 µg/L throughout the reporting period.

At J3EW0032 (Figure 6-4), measured influent concentrations are consistently over-predicted throughout the reporting period. The measured RDX concentration near the start of the reporting period was approximately 0.634 µg/L and the predicted concentration at this same time was approximately 1.62 µg/L. Both increased throughout the reporting period and the measured was approximately 0.848 µg/L near the end of the reporting period and the predicted was approximately 1.56 µg/L at the end of the period..

At J3EWIP1 (Figure 6-5), model predicted concentrations are very similar to measured concentrations. Measured concentrations increased from 0.47 near the start of the reporting period to 0.65 µg/L near the end of the period. Predicted concentrations decreased from 0.54 at the start of the reporting period to 0.35 at the end of the period.

The RDX mass removal for the system determined at the treatment plant during the reporting period (01 December 2010 through 30 November 2011) was 0.46 pounds compared to a model predicted mass removal of 0.67 pounds (Figure 6-7).

6.3 Simulated Capture Zone

The capture zone developed by the numerical model based on pumping stress between December 2010 and November 2011 for the J-3 and FS-12 (adjoining system) were accounted for in the numerical model. The numerical model considers the cumulative effects of partial well penetration within the aquifer, variable recharge rates, and injection wells/infiltration trenches.

Simulated stresses for the “base scenario”, which consisted of the regional model calibrated to 2003 (non-system) conditions, but simulating 2011 injection/extraction rates, produced a hydraulic gradient of 0.0004 ft/ft upgradient of the in-plume well, similar to the September 2011 measured gradient conditions. The in-plume capture zone width as a result of the J3EWIP1 extraction well measures approximately 700 feet, with a simulated stagnation point of approximately 200 feet downgradient of the well. The model simulated capture zone by individual extraction wells is presented in Figure 6-8.

The simulation developed using “average” water table conditions indicates complete plume capture by wells J3EWIP1, J3EW0032 and 90EW0001, respectively. The J3EWIP1 capture zone is the most laterally extensive of the three and any contamination that might not be captured by J3EW1P1 is captured by one or the other of the down gradient wells. The only wells upgradient of J3EWIP1 with any recently measured concentrations greater than minimum regulatory requirements are the perchlorate concentrations at the MW-142 and MW-143 well clusters (MW-142M2 was 6.31 µg/L in September 2011 and MW-143M2 was 6.59 µg/L in September 2010). Simulations presented in the J-3 2010 Annual Report (USACE, 2011) indicated that under “average” water table conditions capture of contaminant at the MW-142 and MW-143 is achieved by J3EWIP1 and under “high” water table conditions capture of contaminant is achieved by J3EW0032, located downgradient of J3EWIP1. The actual capture zones are narrower than shown in Figure 6-8 but are still believed to be wide enough to capture the extent of the perchlorate and RDX plumes as they are presently understood to exist. However, capture of the MW-142 and MW-143 screens by J3EWIP1 under average flow conditions and of the same screens by J3EW0032 under high flow conditions is marginal and the drive point program will reduce the uncertainty associated with this capture zone evaluation.

6.4 Discussion

Overall, both the RDX and perchlorate 2011 observed plumes are smaller than the design model predictions. Additionally, there is more internal heterogeneity in the observed plumes than in the modeled plumes and the plumes form separate lobes along the flow path rather than the contiguous plumes predicted by the model (Figures 6-1 and 6-2). This does not necessarily mean that the observed and simulated masses are different, but that the plume is predicted to spread more rapidly than observed.

Concentrations within the body of the observed plume may fluctuate but several lines of evidence indicate that the remedial system is operating as designed. These lines of evidence include 1) the evaluation of the hydraulic data collected during system startup, which showed that the predicted hydraulic stress closely matched the observed data and 2) a comparison of observed plumes from this and prior annual reports indicate a consistent decrease in the size of the perchlorate and RDX plumes.

Model predictions indicate that, even though the J-3 Range ETR is believed to capture the entirety of the perchlorate and RDX plumes, the magnitude of the predicted mass removed by the three extraction wells is generally over-predicted. For example, the predicted perchlorate concentration has been consistently greater than the measured concentration at J3EWIP1

(Figure 6-5) resulting in an over-prediction in the perchlorate mass removed (Figure 6-6). Also, the predicted RDX concentration has been consistently greater than the measured concentration at J3EW0032 (Figure 6-4) resulting in a significant over-prediction in RDX mass removed (Figure 6-7). In both cases, the 2007.75 plume shells incorporate more mass than is likely present upgradient of each respective extraction well suggesting that the model may ultimately over-predict the cleanup time.

While the model is useful for predicting the general plume shape and magnitude of concentrations, the 2007.75 plume shells show some divergence from the measured plumes and may require updating in the future so that the model can continue to be a useful predictive tool for J-3 Range plume transport. In the end though the J-3 Range model and evaluations suggest that the system is performing as designed with respect to capture, although the heterogeneity in the plume may continue to result in somewhat variable measured concentrations in monitoring wells and extraction well influent water.

7.0 ECOLOGICAL IMPACT MONITORING

Snake Pond and the J-3 Range Wetland are monitored to assess potential ecological impacts associated with the J-3 Range ETR system. Water table elevations adjacent to these surface water bodies are measured annually in accordance with the J-3 ETR system monitoring plan (USACE 2011) to evaluate potential effects of the groundwater extraction and reinjection on surface water levels.

7.1 Snake Pond

Monitoring wells MW-251M3, MW-217M4, and 90MW0101A were installed on the northern shoreline of Snake Pond south of extraction wells 90EW0001 and J3EW0032. Water table measurements were scheduled for these three monitoring wells in September 2011; however, only 90MW0101A was measured because wells MW-251M3 and MW-217M4 were submerged and inaccessible at the time of the monitoring events. This has been the case since 2008. Consequently, a continuous series of water level measurements is available only for well 90MW0101A.

Water table elevations at 90MW0101A, which are representative of surface water elevations in Snake Pond, have increased by approximately 5 feet during the past decade of monitoring. A similar pattern is observed in water levels measured during that same time period at background well MW-128M2 near the top of the groundwater mound. A clear correlation is evident in the overall trend and year-to-year fluctuations at these two monitoring points (Figure 7-1). The results suggest that surface water levels at Snake Pond are predominantly influenced by natural variations in the regional water table and not the J-3 Range ETR system. Though unlikely, based on model predictions, it is possible that the J-3 Range ETR system wells have minor influences on surface water levels at Snake Pond. These subtle changes, however, would likely present no significant ecological impacts relative to the regional surface water level changes observed over the past 10 years.

In addition to collecting groundwater samples, water samples were collected at two locations within Snake Pond (LKSNK0005 and LKSNK0006) and analyzed for perchlorate and explosives. During the reporting period, samples were collected three times; once each on 08 April 2011, 25 May 2011 and 21 July 2011. The depth of the sample at LKSNK0005 was 4 feet below the water surface and the depth of the LKSNK0006 sample was 1 foot below the water surface. In all cases, the perchlorate and explosives concentrations were determined to be less than their respective detection limits.

7.2 J-3 Wetland

Piezometer ECPZJ3W0001 was installed to monitor the effects of the J-3 Range ETR system on surface water levels at the J-3 Range Wetland. Since 2006, water level measurements in ECPZJ30001 have ranged from 73.76 in July 2008 to the current elevation of 75.27 feet msl, measured on 21 September 2011 (Table 4-2). With the exception of one recent measurement

near the top of the groundwater mound (at well MW-128M2), all of the ECPZJ3W0001 elevations have been higher than the regional water table suggesting that a perched condition may exist at the J-3 Range Wetland. Additionally, when compared to natural elevation changes upgradient at the top of the mound (MW-128M2) and downgradient at Snake Pond (90MW0101A), there are no apparent trend similarities (Figure 7-1) suggesting there is poor hydraulic communication between the perched wetland and aquifer below. Under these conditions, it is unlikely that surface water elevation changes observed at the J-3 Wetland are related to the J-3 Range ETR system. Therefore, no significant ecological impacts associated with the J-3 Range ETR system are expected at the J-3 Range Wetland.

8.0 RECOMMENDATIONS

Recommendations for modification to the J-3 Range plume ETR system operations and monitoring are presented in this section.

8.1 Plant Operation and Sampling

The J-3 Range plume ETR system is treating groundwater as designed. Current monitoring procedures identify the potential for system breakthrough and enable timely replacement of treatment media. (E.g., perchlorate was measured at the action level of 0.35 µg/L in the J3-MID-2 sample on 8 August 2011 and again on 8 September 2011 leading to IX media replacement on 19-20 September 2011.) Thus, no changes are recommended to the current system operating and monitoring procedures.

8.2 Wellfield Recommendations

There are no recommendations for modifying wellfield flow rates at this time. As additional monitoring well and influent data is collected it will be evaluated, and recommendations may be made in future annual reports.

8.3 Hydraulic Monitoring

There are no recommendations for modifying hydraulic monitoring locations within the J-3 Range area at this time. As additional monitoring well and influent data is collected it will be evaluated, and recommendations may be made in future annual reports.

It is recommended, however, that the monitoring point elevation for the MW-227 well cluster be resurveyed by November 2012 to insure that the interpreted water levels are correct.

8.4 Chemical Monitoring

As additional monitoring well and influent data is collected it will be evaluated, and recommendations may be made in future annual reports.

- Monitoring well 90MP0059B is recommended for annual perchlorate sampling to replace the annual sampling that has historically occurring at wells in and around Snake Pond that are currently inundated and are expected to remain so for the foreseeable future.

9.0 REFERENCES

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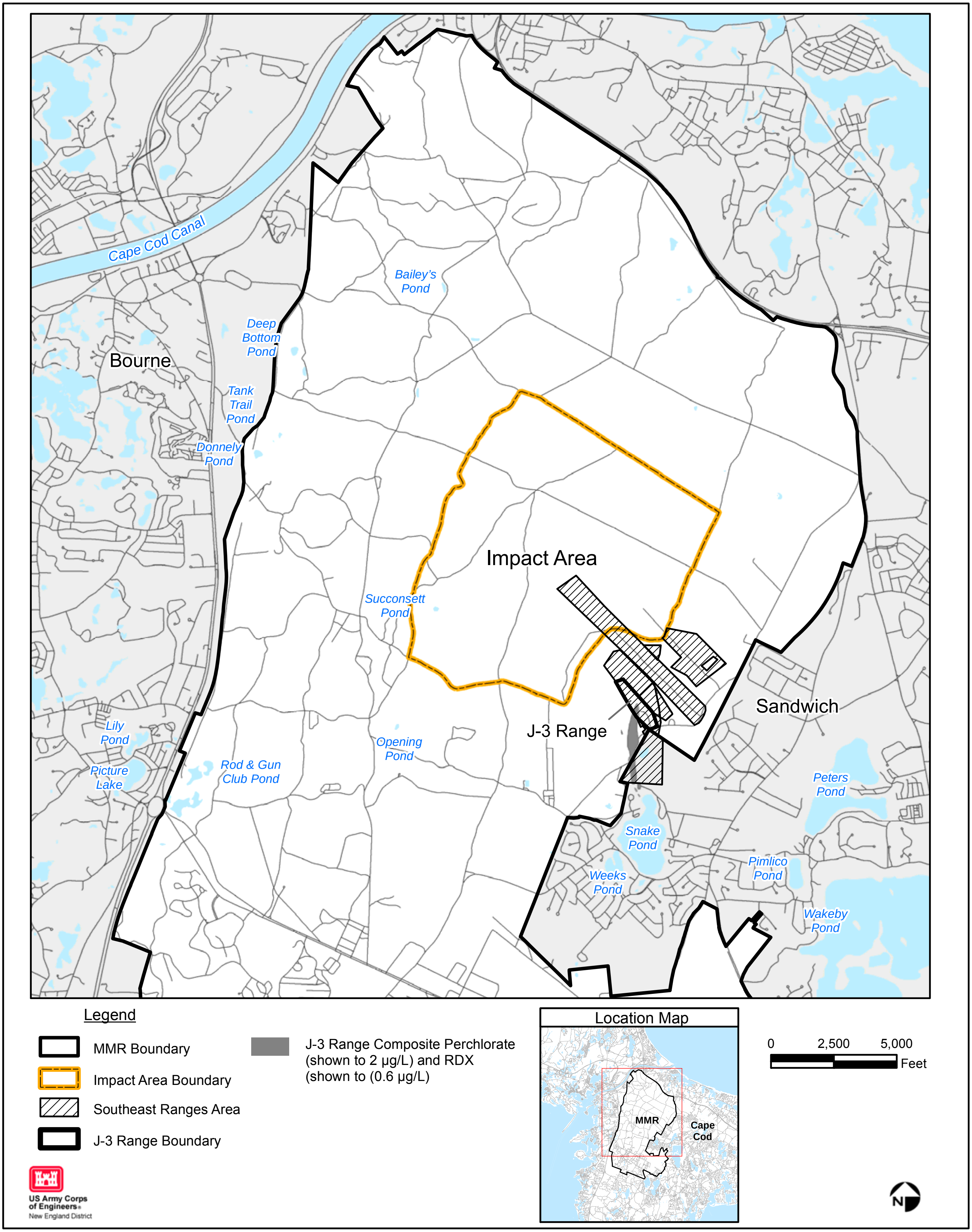
FIGURES



Location of J-3 Range

FIGURE 1-1

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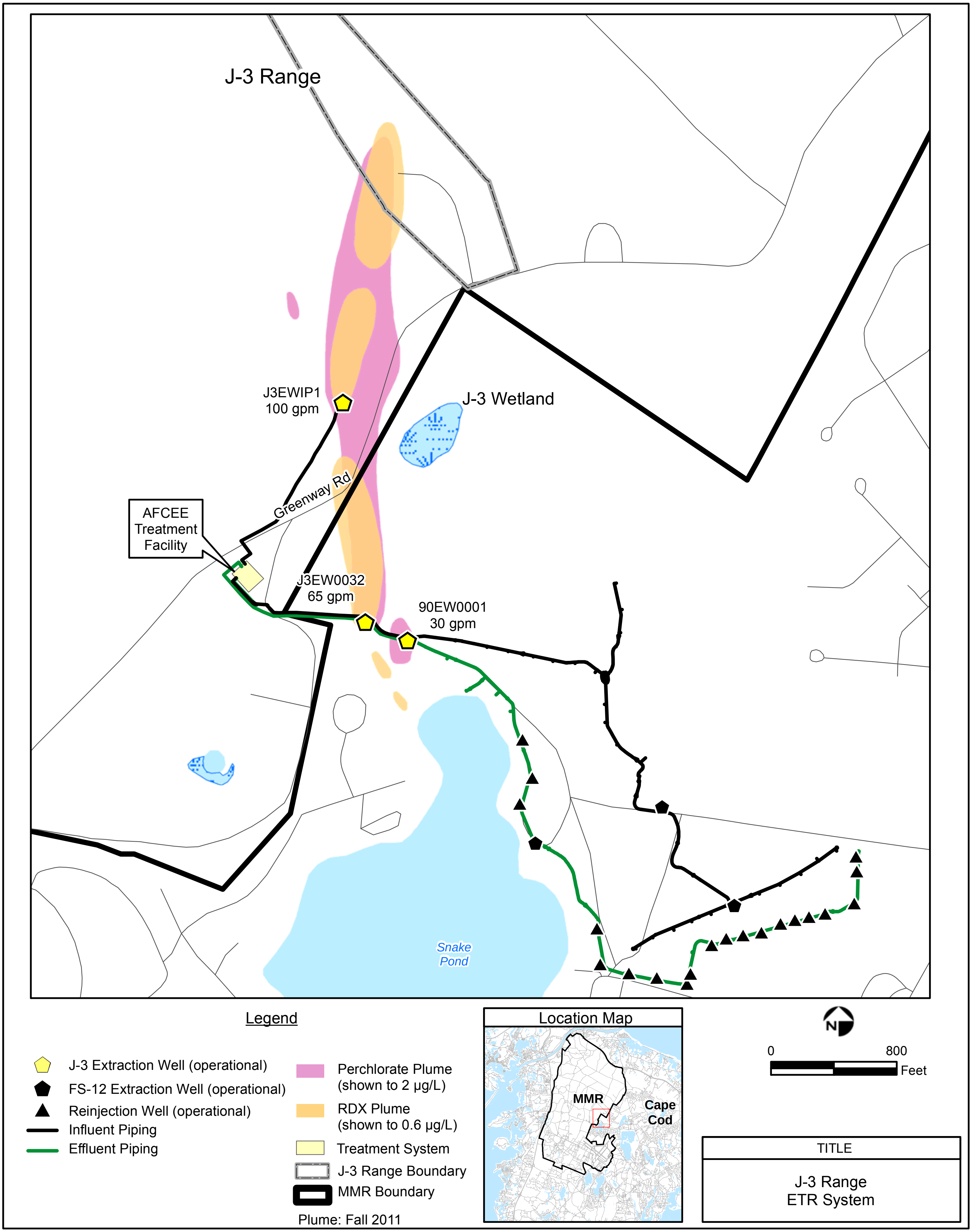
March 13, 2012 DWN: MTW CHKD: KJH

Impact Area
Groundwater Study Program



TITLE

J-3 Range
ETR System

US Army Corps
of Engineers
New England District

Impact Area
Groundwater Study Program

FIGURE
2-1

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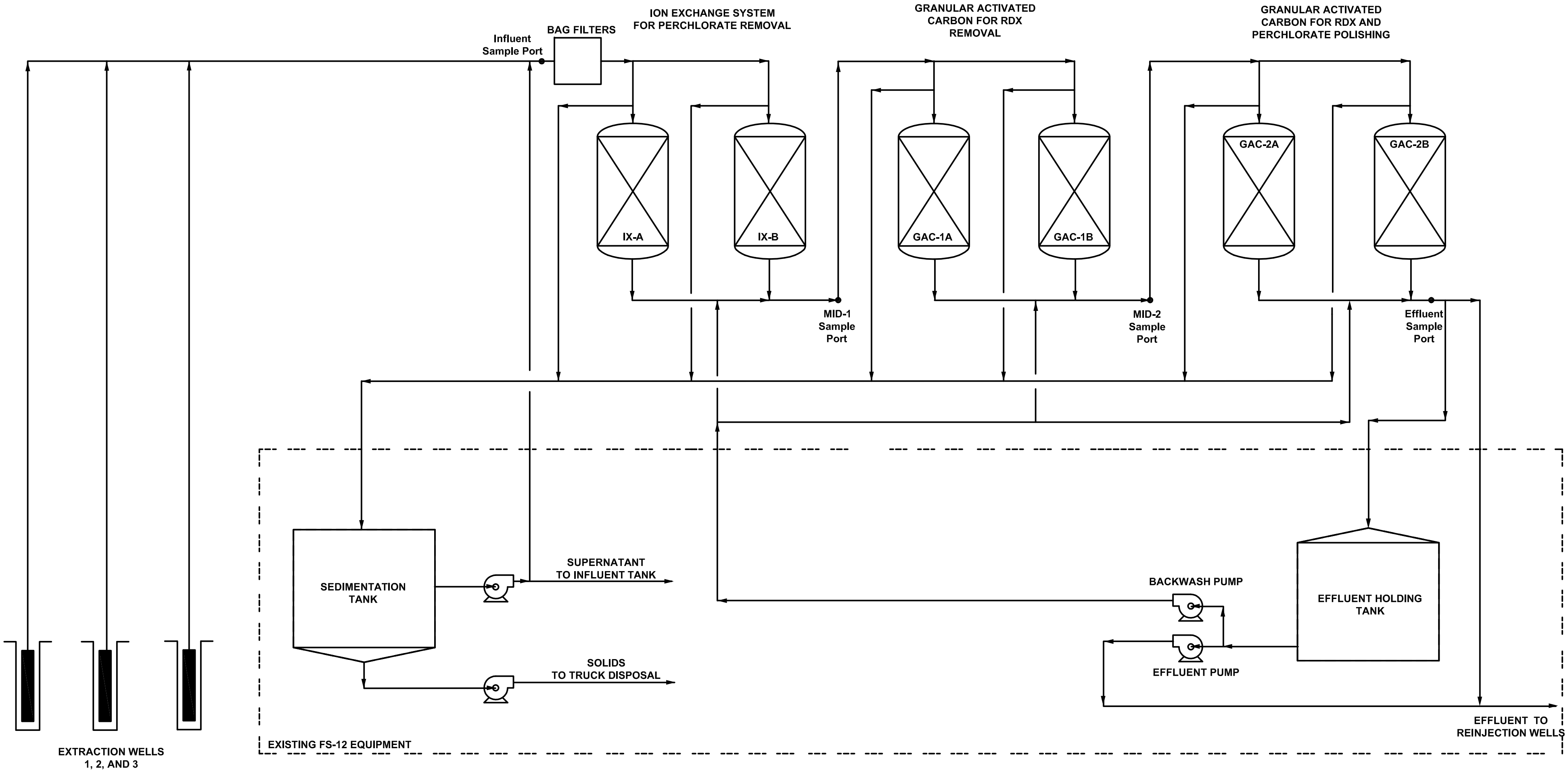


Impact Area Groundwater Study Program

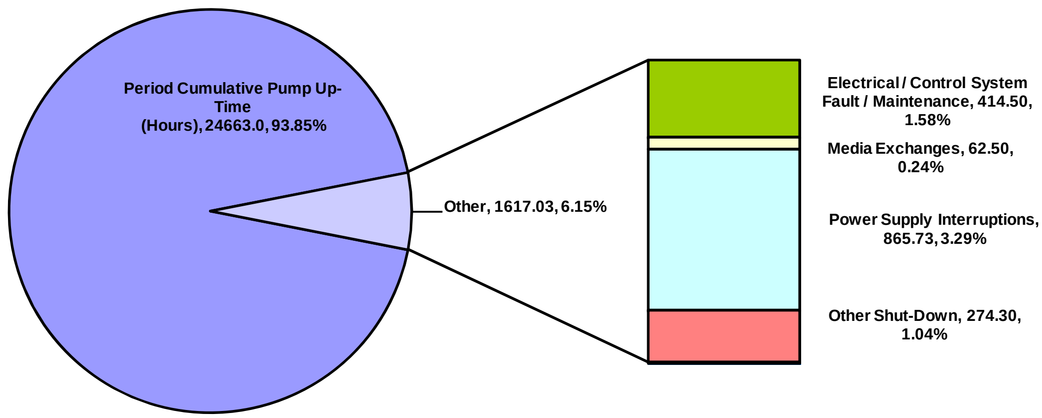
J-3 Plume RRA Process Flow Diagram

Massachusetts Military Reservation
Cape Cod, Massachusetts

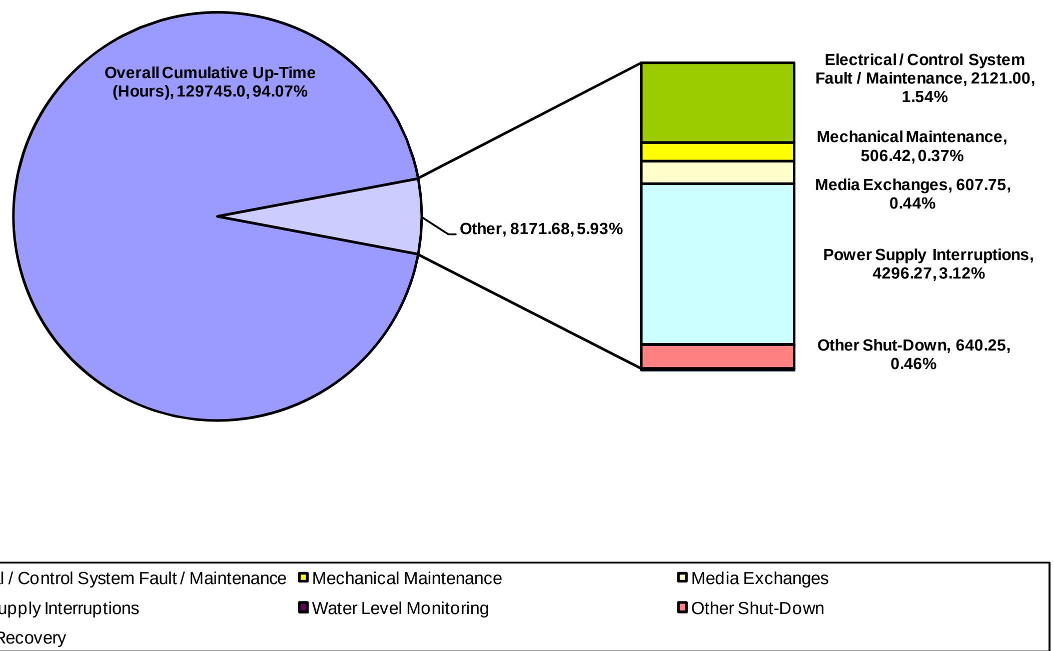
Figure 2-2

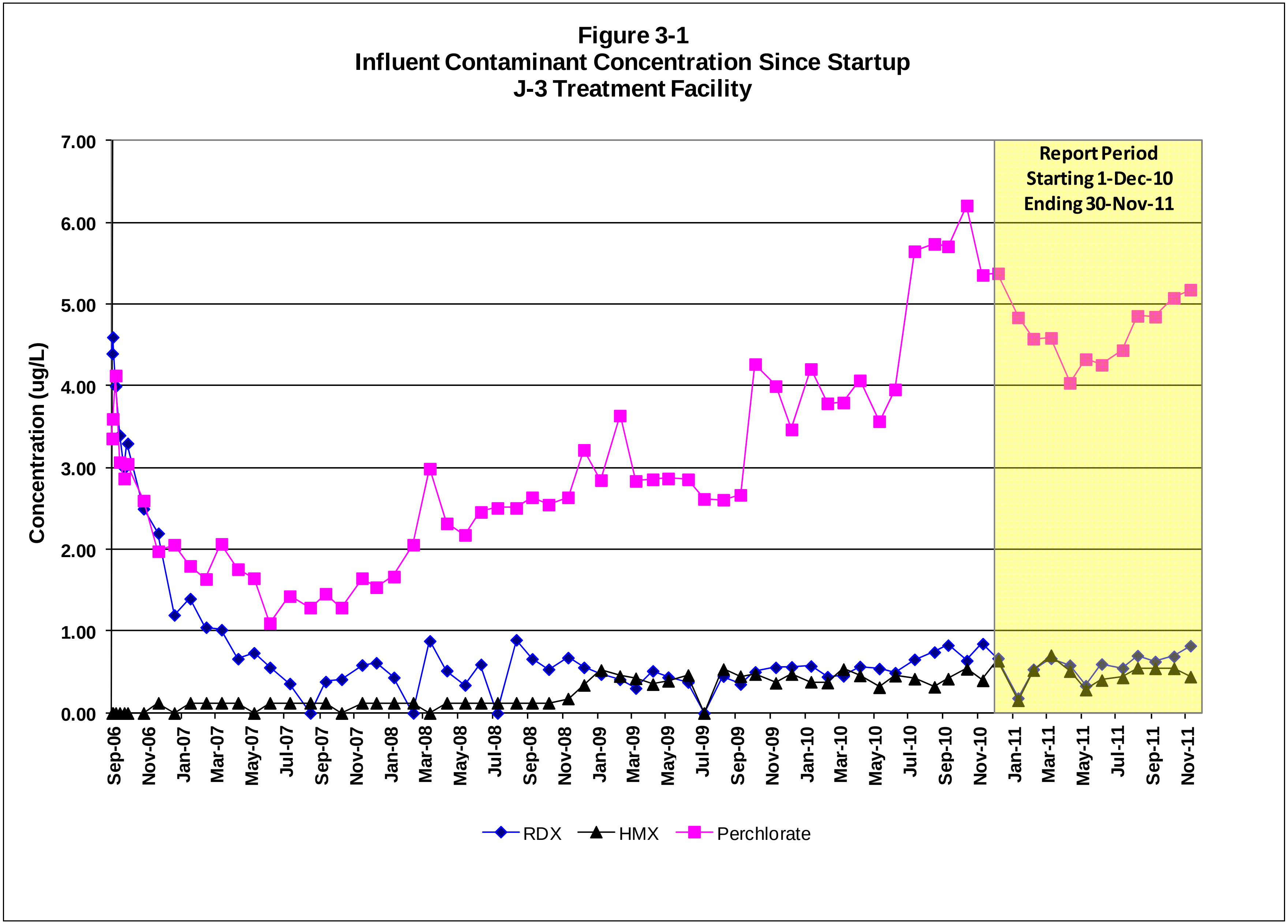
Figure 2-3
Downtime (pump hours) by Category
J-3 Treatment Facility

a. Downtime December 2010 through November 2011



b. Downtime Since Remedy Startup (August 2006)





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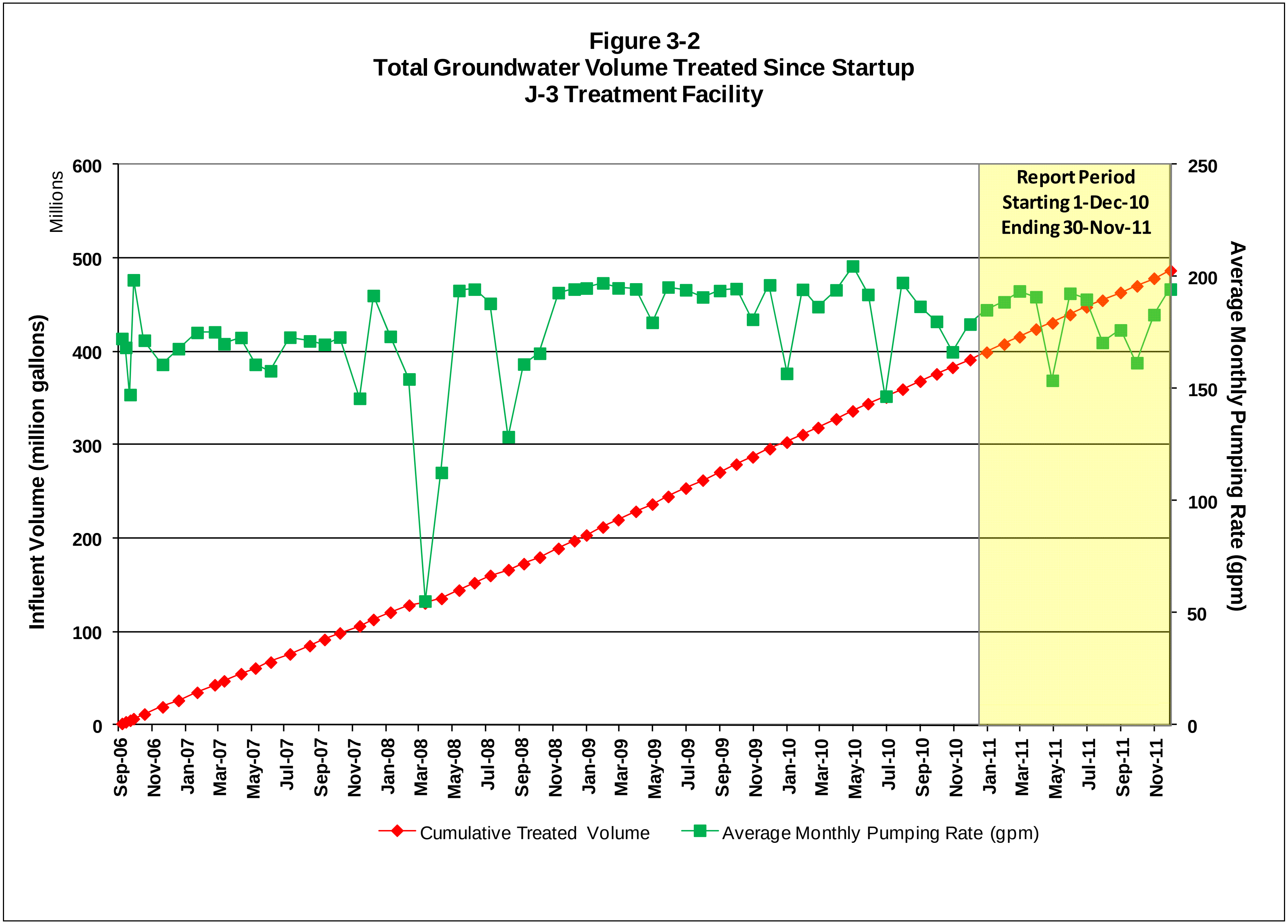

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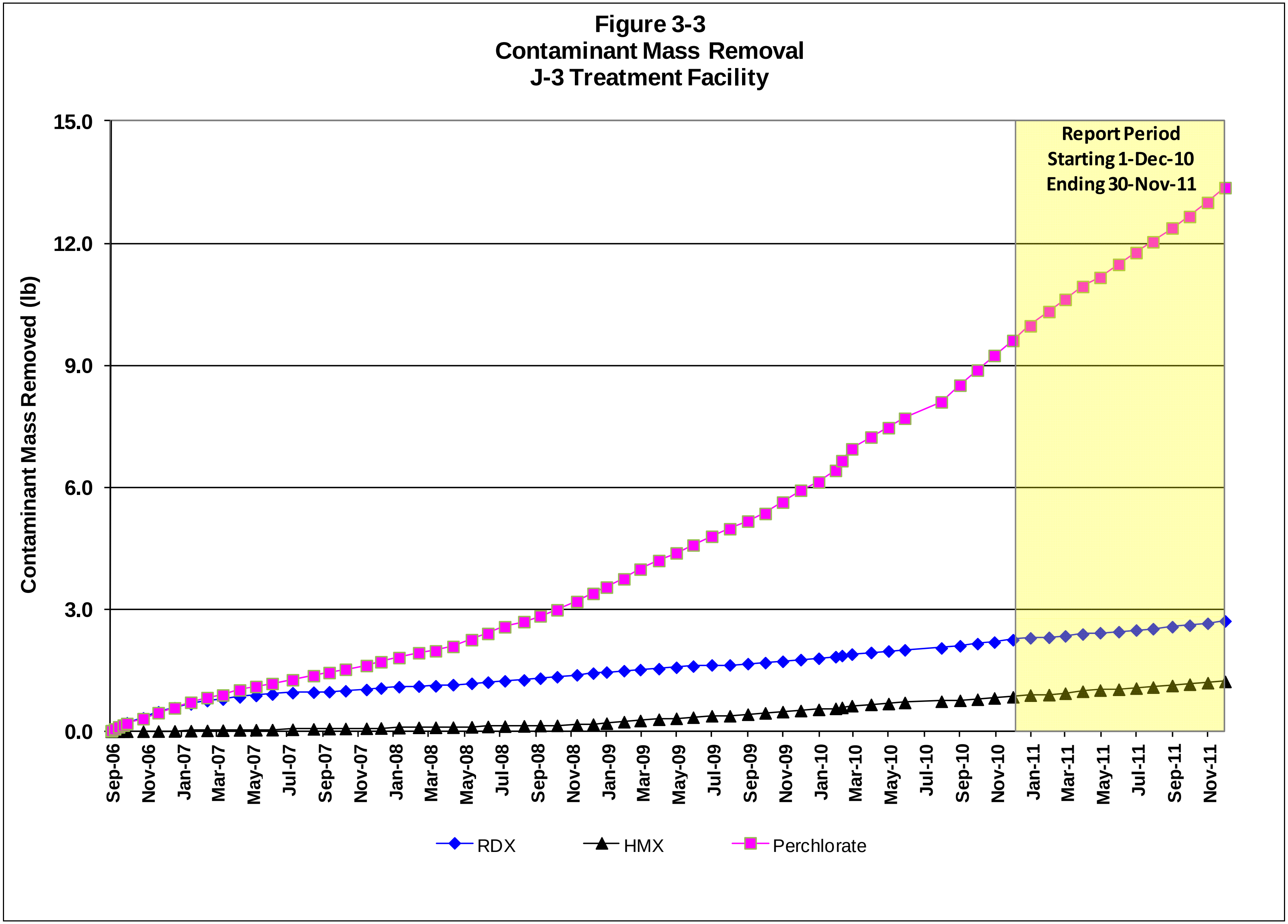
Impact Area
Groundwater Study Program



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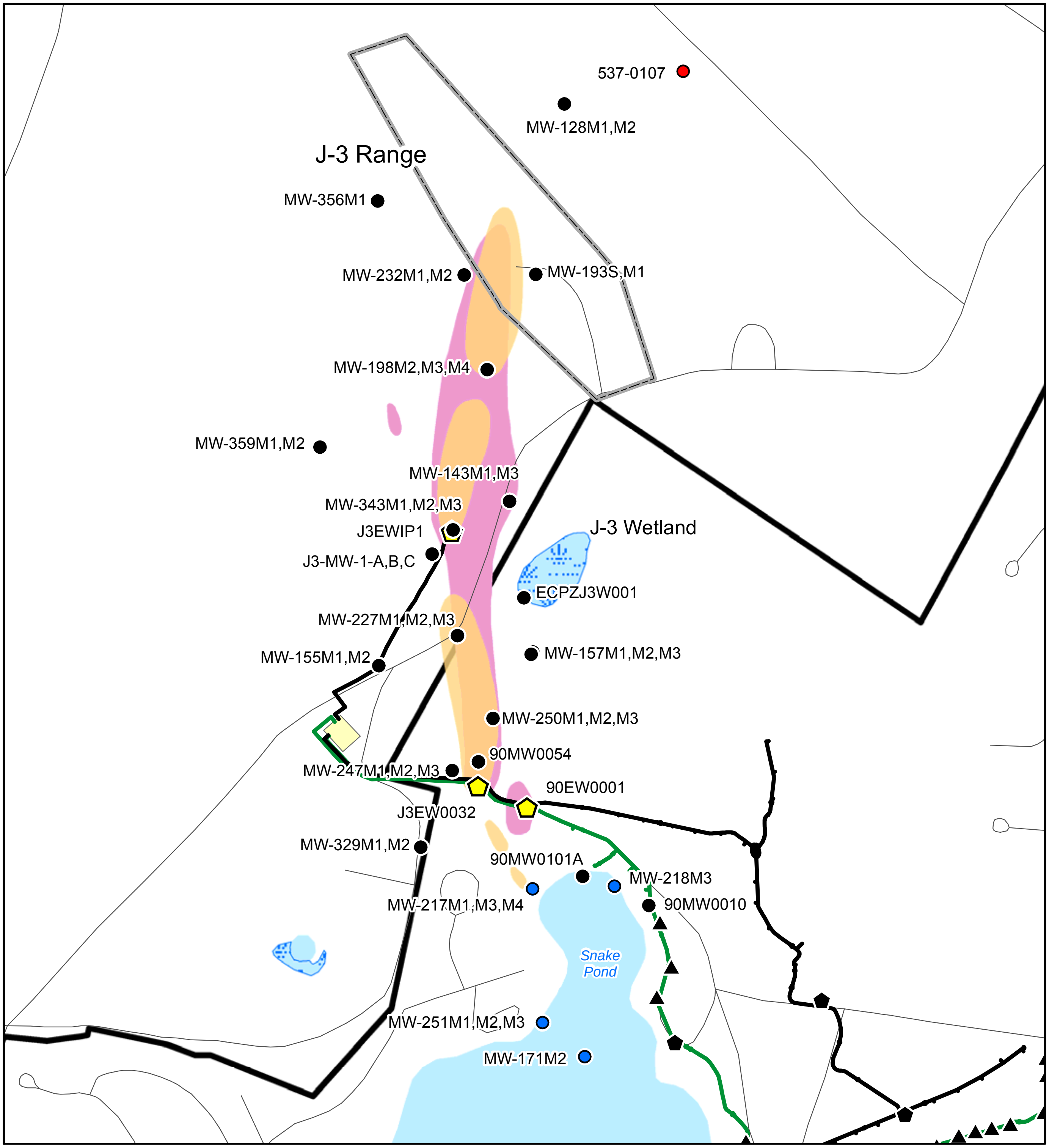
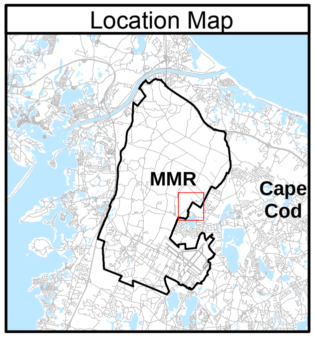


Legend

- ● Monitoring Well
- ● Equipped with Pressure Transducer
- ● Monitoring Well (Submerged)
- ⬠ J-3 Extraction Well (operational)
- ⬟ FS-12 Extraction Well (operational)
- ▲ Reinjection Well (operational)
- Influent Piping
- Effluent Piping
- Perchlorate Plume (shown to 2 µg/L)
- RDX Plume (shown to 0.6 µg/L)
- Treatment System
- J-3 Range Boundary
- MMR Boundary

Plume: Fall 2011

Location Map



N

0 800 Feet

TITLE

J-3 Range Water-Level Monitoring Network

Impact Area Groundwater Study Program

FIGURE 4-1

US Army Corps of Engineers
New England District

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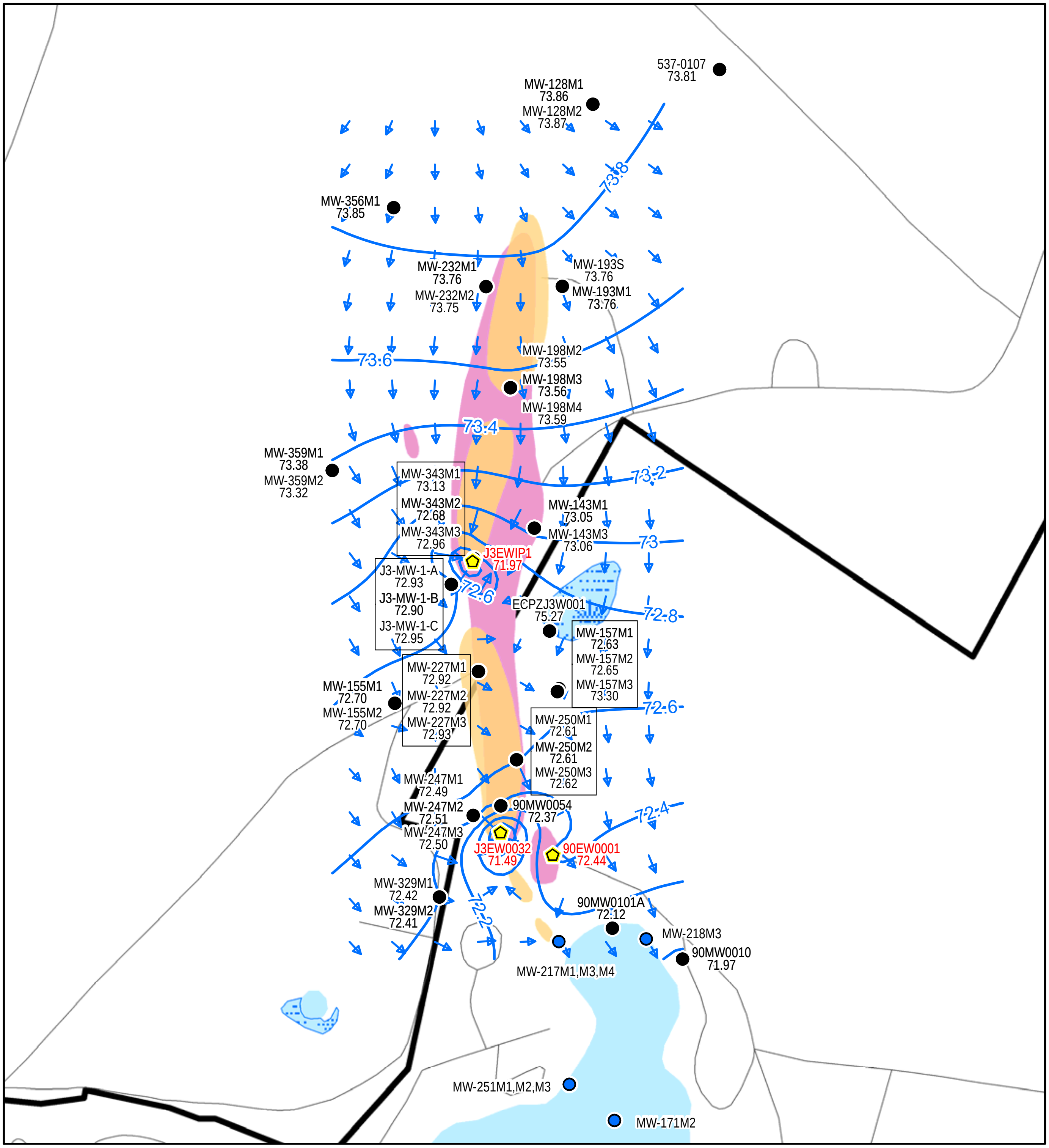
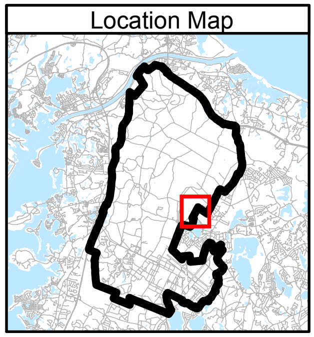
M:\MMR\2012\J3\AnnRpt\MXDs\Fig4-1_031312.mxd
May 29, 2012 DWN: MTW CHKD: KJH



Legend

	Extraction Well	71.49	Estimated Elevation
	Monitoring Well	MW-157M1 72.63	Value used in contouring
		MW-157M2 72.65	Value not used in contouring
	Monitoring Well (Submerged)		
	Perchlorate Plume (shown to 2 μg/L)		
	RDX Plume (shown to 0.6 μg/L)		
	MMR Boundary		Flow Vectors
72.8	Potentiometric Contours, 0.2 foot mean sea level intervals		

Location Map



N

0 750 Feet

TITLE

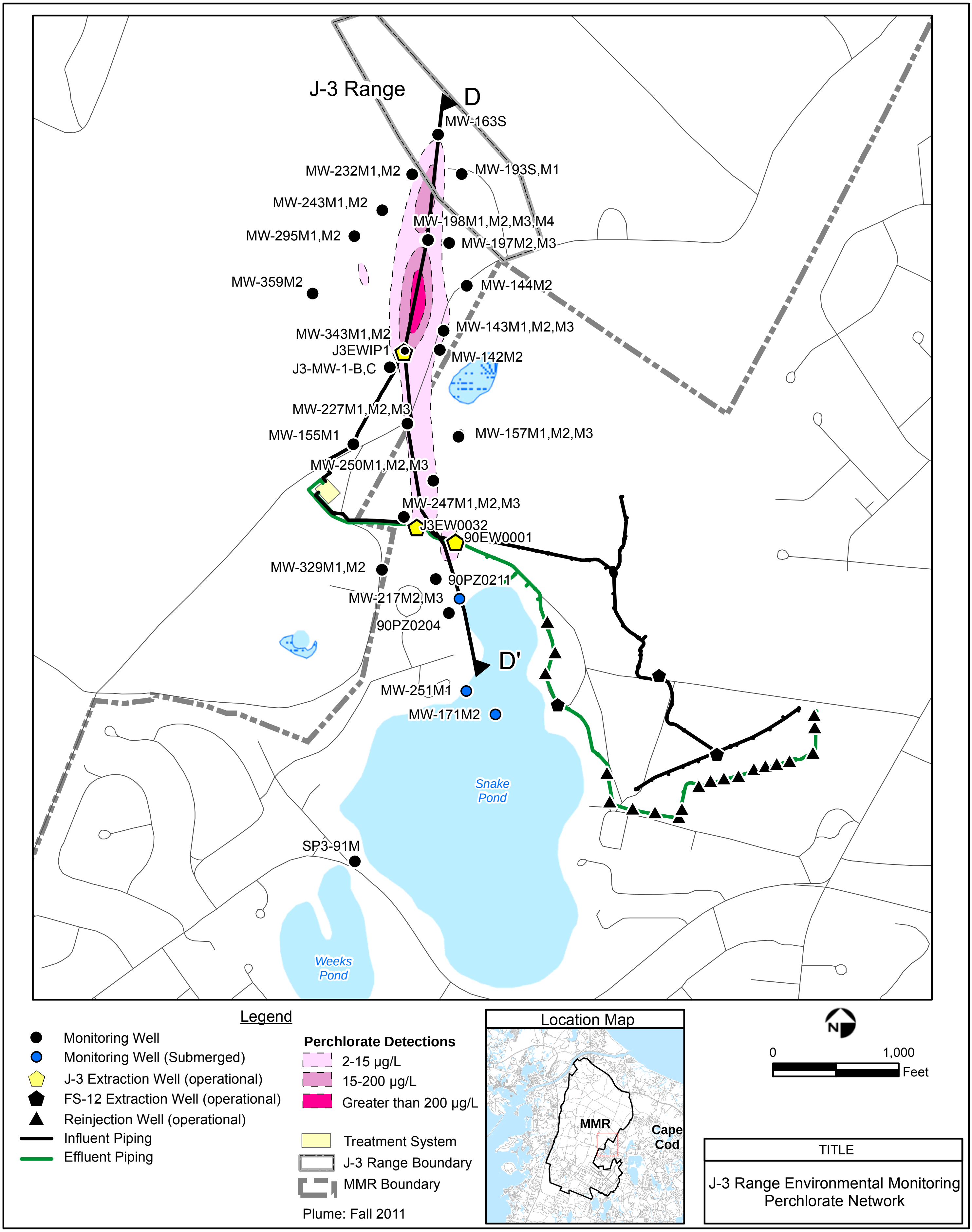
J-3 Groundwater Potentiometric Map for 21 September 2011

US Army Corps of Engineers New England District

Impact Area Groundwater Study Program

FIGURE 4-2

M:\MMR\2012\J3\AnnRpt\Figures\Fig4-2_032912.pdf
M:\MMR\2012\J3\AnnRpt\MXDs\Fig4-2_031312.mxd
March 29, 2012 DWN: MTW CHKD: KJH



TITLE

J-3 Range Environmental Monitoring Perchlorate Network

US Army Corps of Engineers
New England District

Impact Area Groundwater Study Program

FIGURE 5-1

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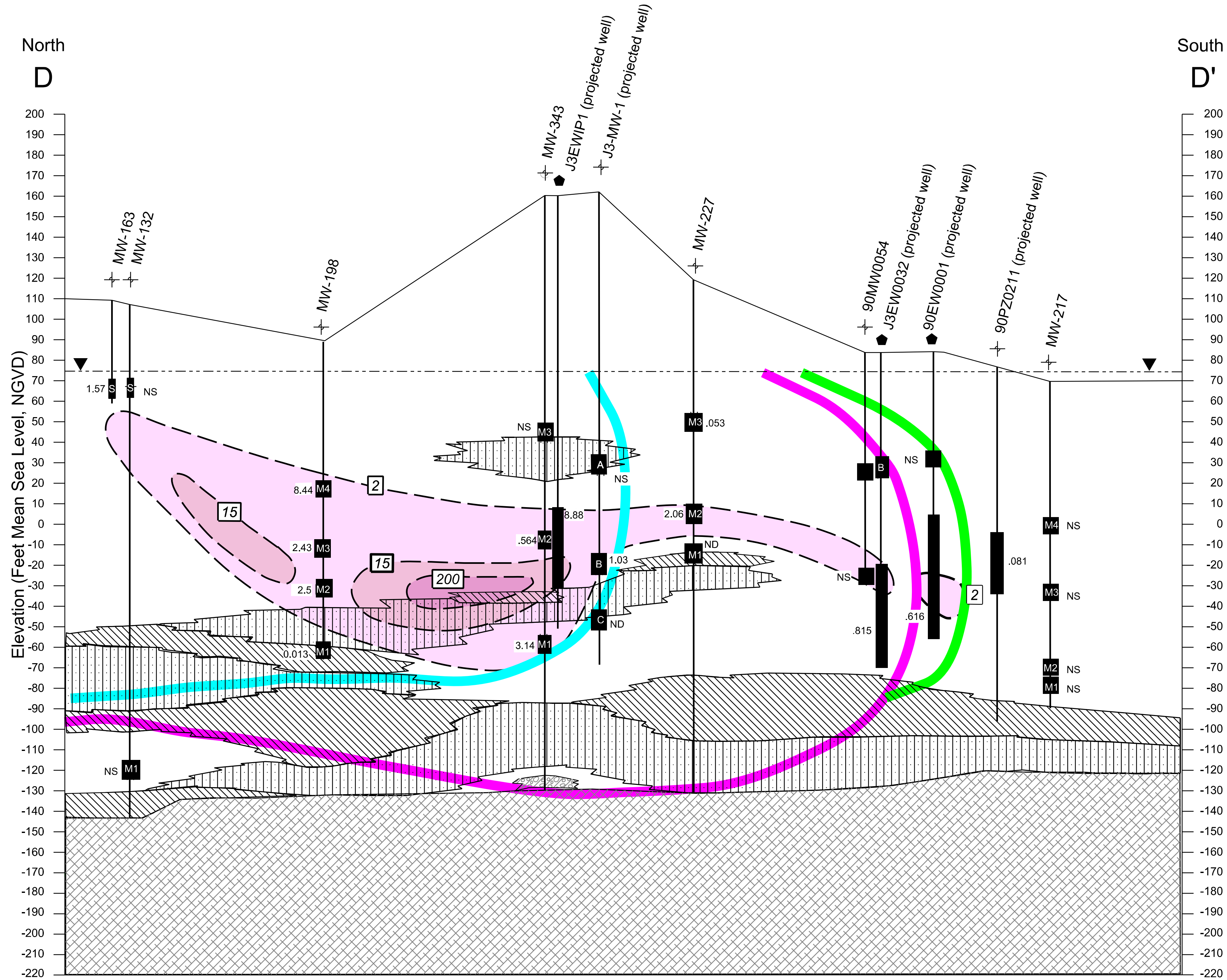
March 22, 2012 DWN: MTW CHKD: KJH



Legend

Extraction Well
Monitoring Well
Water table
Well screen ID

Sand
Silt/ Clay
Sand and Silt/Clay
Basal Gravel/Sand
Bedrock

NGVD National Geodetic Vertical Datum

NS Not Sampled
J Estimated Concentration
ND Nondetect
µg/L Micrograms per liter

2-15 µg/L
15-200 µg/L
Greater than 200 µg/L

Vertical Capture Zone for J3EWIP1 2011 Operational Conditions
Vertical Capture Zone for J3EW0032 2011 Operational Conditions
Vertical Capture Zone for 90ew0001 2011 Operational Conditions

Data Source: IAGWSP EDMS Database, Water level from 2011 Synoptic Event.

— Geologic Contact (dashed where inferred)

Note: Perchlorate concentrations were measured during September 2011 sampling event.

HORIZONTAL SCALE: 1"=60'
0' 30' 60'

0' 30' 60'
VERTICAL SCALE: 1"=60'

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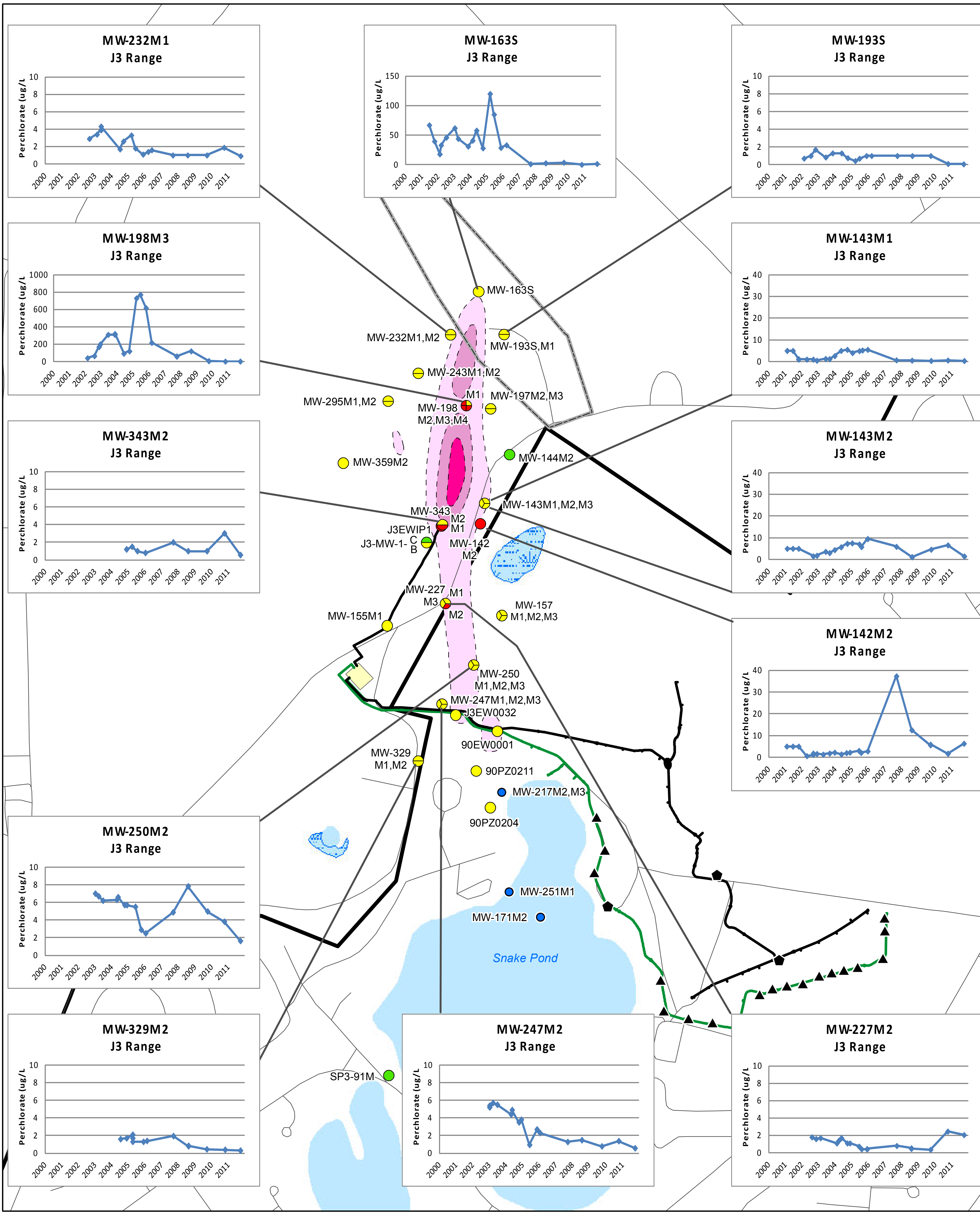
IMPACT AREA GROUNDWATER
STUDY PROGRAM
J-3 SITE
PLUME CROSS SECTION D-D'
ILLUSTRATING PERCHLORATE DISTRIBUTIONS
AND GEOLOGY - FALL 2011

DATE: 3/20/2012 PLOT SCALE: 1"=60'-0"	FILE NAME: J3_PER_DD_Fig-5-2-3-20-2012.DGN	FIGURE 5-2

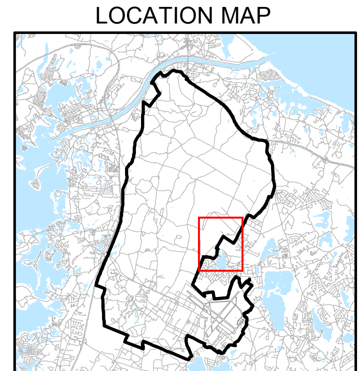


FS-12 Extraction Well (operational)
Reinjection Well (operational)
Influent Piping
Effluent Piping
Treatment System
J-3 Range Boundary
MMR Boundary

Perchlorate Detections
2-15 µg/L
15-200 µg/L
Greater than 200 µg/L
Plume: Fall 2011

Perchlorate Detections in Groundwater
No Detection
Detection at or below 2 µg/L
Detection above 2 µg/L
Indicates different detections in different well screens
Monitoring Well (Submerged)

LOCATION MAP



N

0 700 Feet

NOTES & SOURCES
Base Data from US Geological Survey
7 1/2 minute Topographic Maps
Source: MassGIS

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J-3 Range Groundwater Perchlorate Trends

FIGURE
5-3

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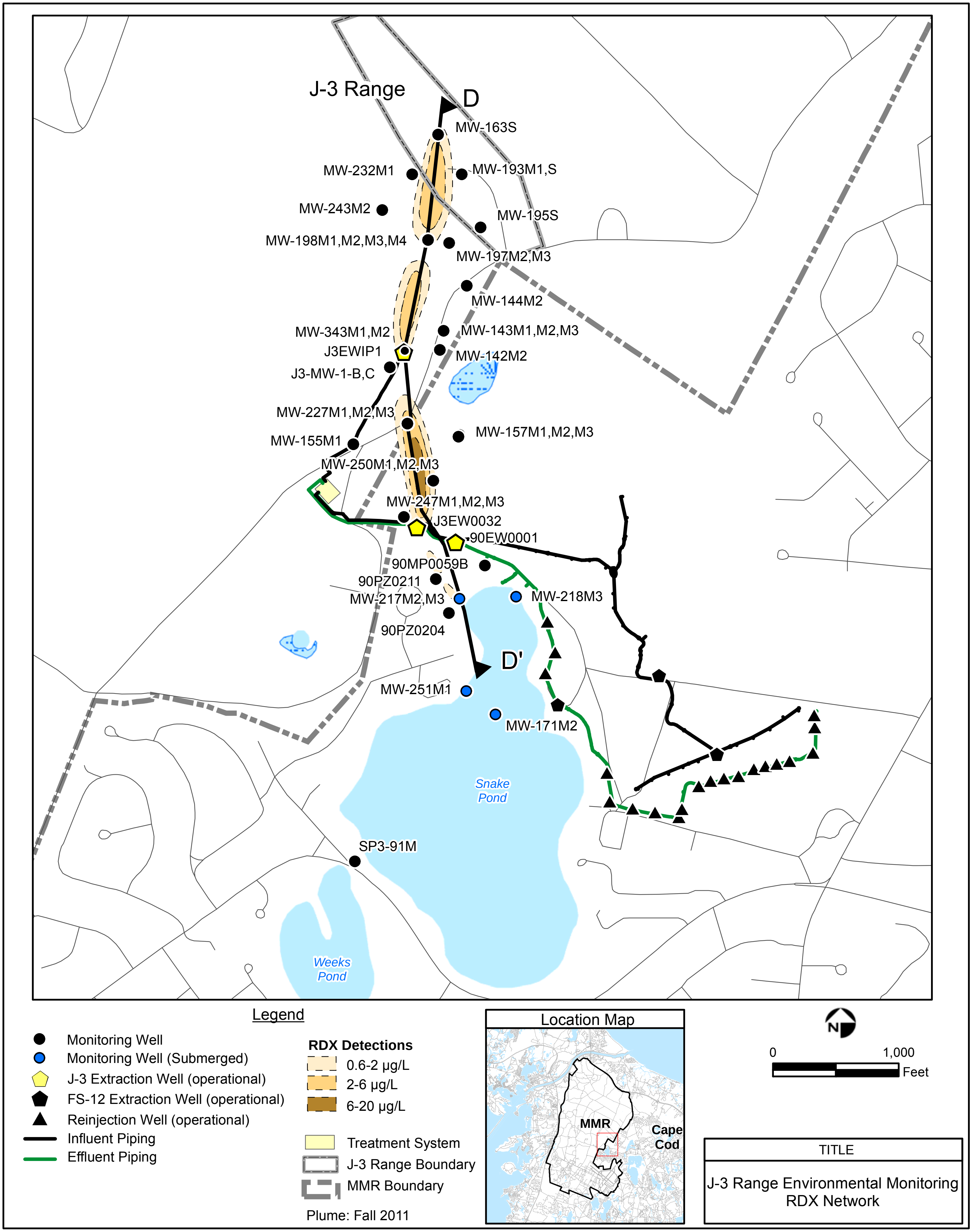
M:\MMR\2012\J3\AnnRpt\MXDs\Fig5-3_031312.mxd
March 30, 2012 DWN: MTW CHKD: KJH



TITLE

J-3 Range Environmental Monitoring RDX Network

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New England District

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FIGURE 5-4

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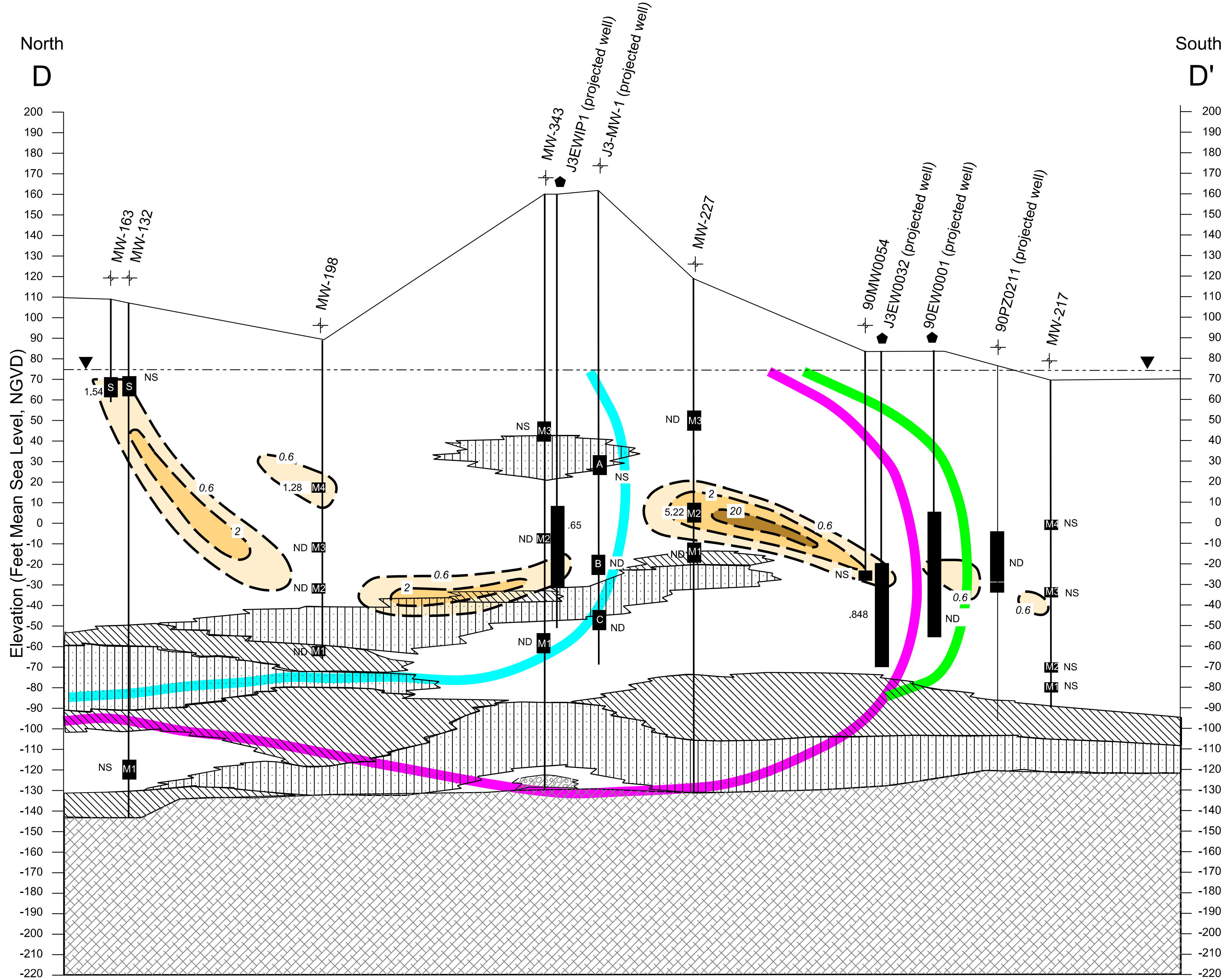
M:\MMR\2012\J3\AnnRpt\MXDs\Fig5-4_031312.mxd
March 22, 2012 DWN: MTW CHKD: KJH



Data Source: IAGWSP EDMS Database,
Water level from 2011 Synoptic Event.

Legend

Extraction Well	Sand	NS	Not Sampled	0.6-2 µg/L	Vertical Capture Zone for J3EWIP1 2011 Operational Conditions
Monitoring Well	Silt/ Clay	J	Estimated Concentration	2-20 µg/L	Vertical Capture Zone for J3EW0032 2011 Operational Conditions
Water table	Sand and Silt/Clay	ND	Nondetect	20-200 µg/L	Vertical Capture Zone for 90ew0001 2011 Operational Conditions
Well screen ID	Basal Gravel/Sand	µg/L	Micrograms per liter		
	Bedrock				

NGVD National Geodetic Vertical Datum

Note: The most downgradient lobe is projected from the west of the cross section.

— Geologic Contact (dashed where inferred)

Note: RDX concentrations were measured during September 2011 sampling event.

HORIZONTAL SCALE: 1"=500'
0' 250' 500'

0' 30' 60'
VERTICAL SCALE: 1"=60'

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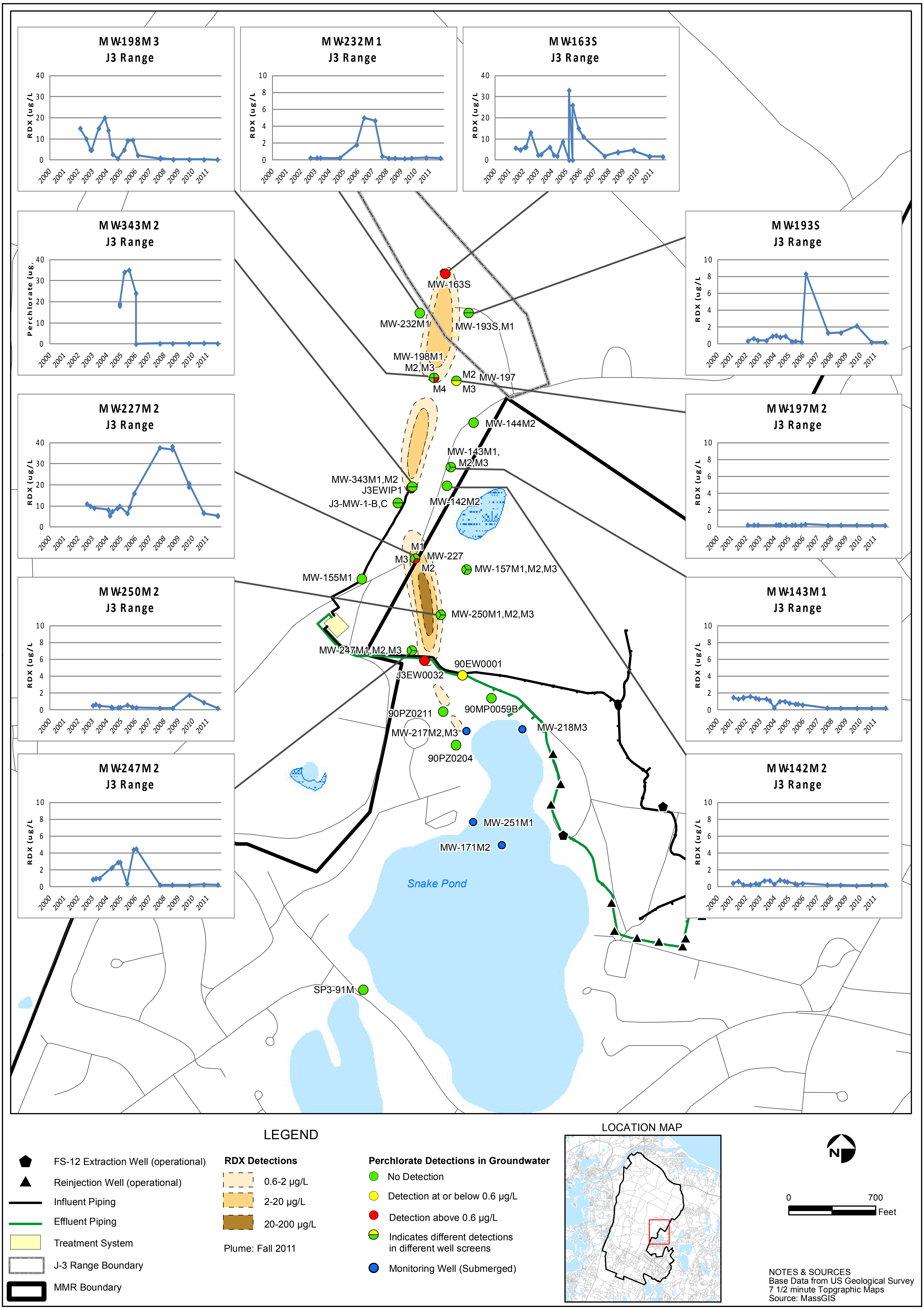
STUDY PROGRAM
J-3 SITE
PLUME CROSS SECTION ADD'
ILLUSTRATING RDX DISTRIBUTIONS
AND GEOLOGY - FALL 2011

DATE: 03/13/2012 PLOT SCALE: 1"=60'-0"	FILE NAME: J3_RDX_DD_Fig-5-4-03-13-2012.DGN	FIGURE 5-5



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Impact Area Groundwater Study Program

J-3 Range Groundwater RDX Trends

FIGURE 5-6

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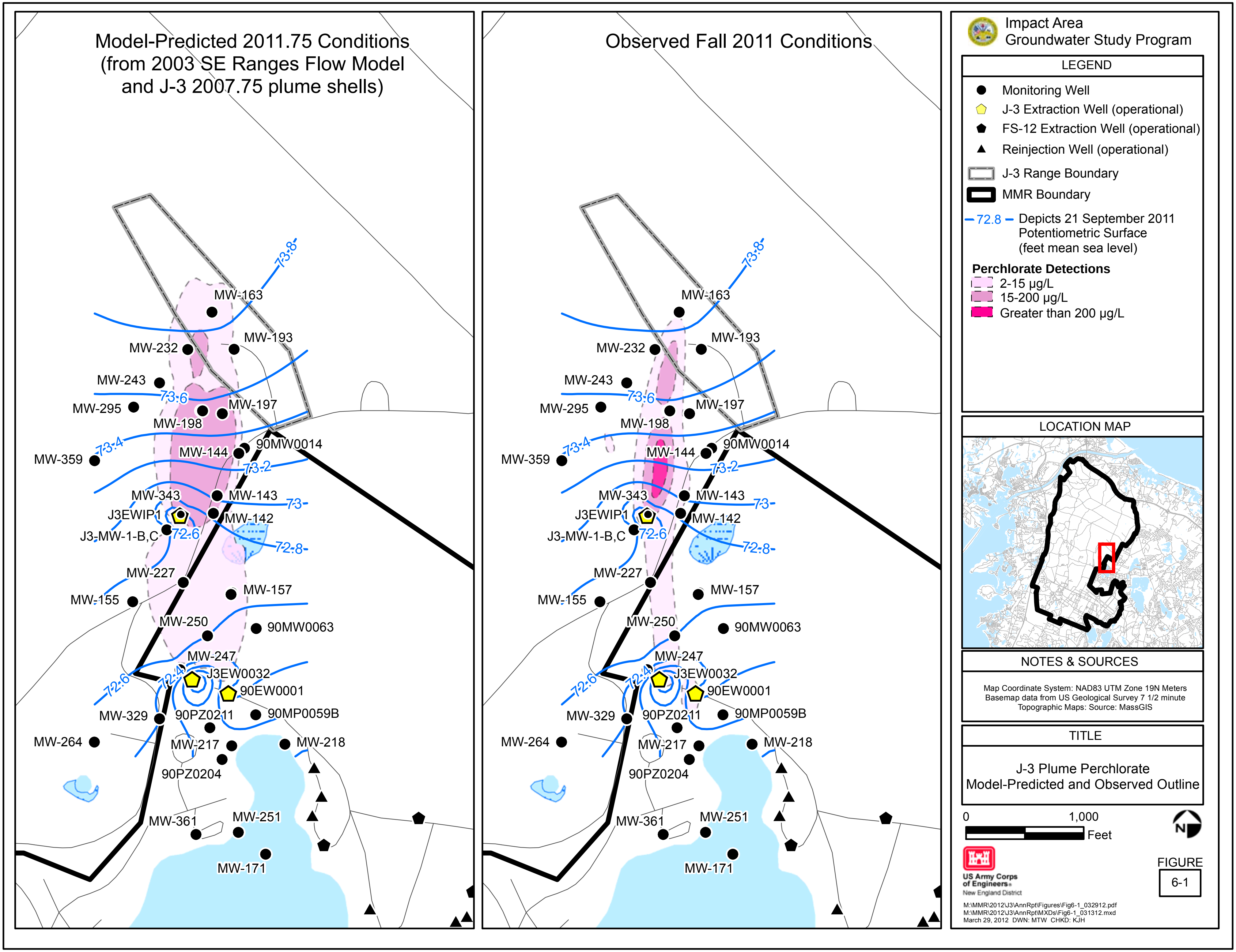
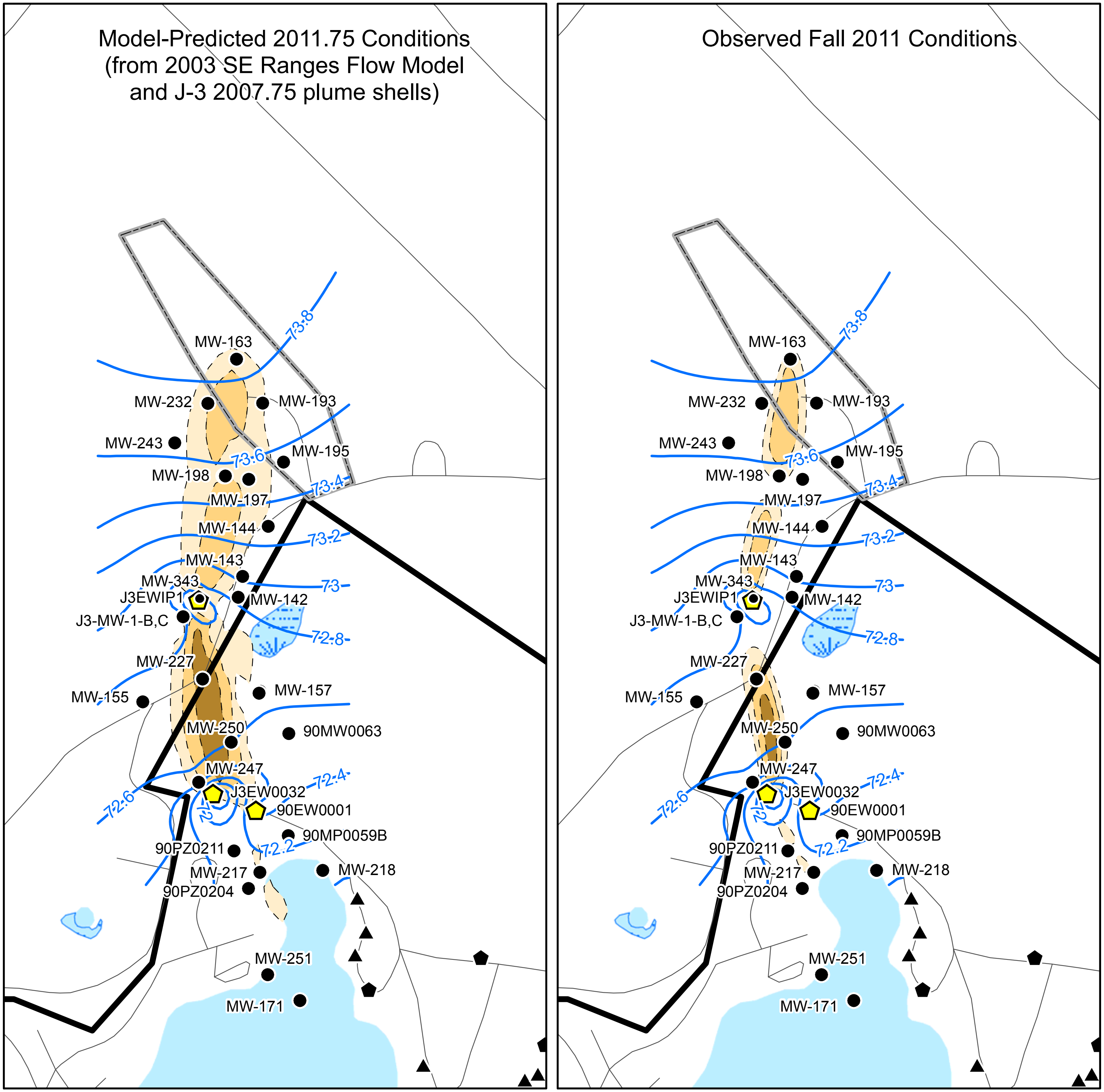
March 22, 2012 DWN: MTW CHKD: KJH



Model-Predicted 2011.75 Conditions (from 2003 SE Ranges Flow Model and J-3 2007.75 plume shells)
Observed Fall 2011 Conditions
MW-163
MW-193
MW-232
MW-243
MW-295
MW-197
MW-198
MW-359
MW-144
90MW0014
MW-343
MW-143
J3EWIP1
MW-142
J3-MW-1-B,C
MW-227
MW-157
MW-155
MW-250
90MW0063
MW-247
J3EW0032
90EW0001
MW-329
90PZ0211
90MP0059B
MW-264
MW-217
MW-218
90PZ0204
MW-361
MW-251
MW-171
73.8
73.6
73.4
73.2
73
72.8
72.6
72.4
Impact Area
Groundwater Study Program
LEGEND
Monitoring Well
J-3 Extraction Well (operational)
FS-12 Extraction Well (operational)
Reinjection Well (operational)
J-3 Range Boundary
MMR Boundary
72.8 Depicts 21 September 2011 Potentiometric Surface (feet mean sea level)
Perchlorate Detections
2-15 µg/L
15-200 µg/L
Greater than 200 µg/L
LOCATION MAP
NOTES & SOURCES
Map Coordinate System: NAD83 UTM Zone 19N Meters
Basemap data from US Geological Survey 7 1/2 minute Topographic Maps: Source: MassGIS
TITLE
J-3 Plume Perchlorate Model-Predicted and Observed Outline
0
1,000
Feet
N
US Army Corps of Engineers
New England District
FIGURE
6-1
M:\MMR\2012\J3\AnnRpt\Figures\Fig6-1_032912.pdf
M:\MMR\2012\J3\AnnRpt\MXDs\Fig6-1_031312.mxd
March 29, 2012 DWN: MTW CHKD: KJH



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Groundwater Study Program

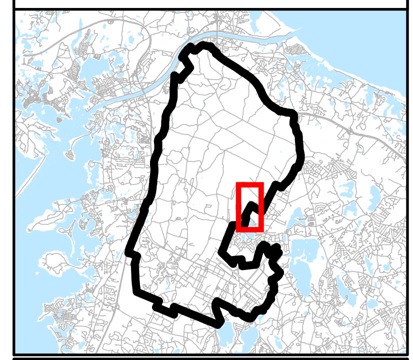
LEGEND

- Monitoring Well
- J-3 Extraction Well (operational)
- FS-12 Extraction Well (operational)
- Reinjection Well (operational)
- J-3 Range Boundary
- MMR Boundary
- 72.8 Depicts 21 September 2011 Potentiometric Surface (feet mean sea level)

RDX Detections

- 0.6-2 µg/L
- 2-20 µg/L
- 20-200 µg/L

LOCATION MAP



NOTES & SOURCES

Map Coordinate System: NAD83 UTM Zone 19N Meters
Basemap data from US Geological Survey 7 1/2 minute
Topographic Maps: Source: MassGIS

TITLE

J-3 Plume RDX
Model-Predicted and Observed Outline

0 1,000 Feet

N

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FIGURE 6-2

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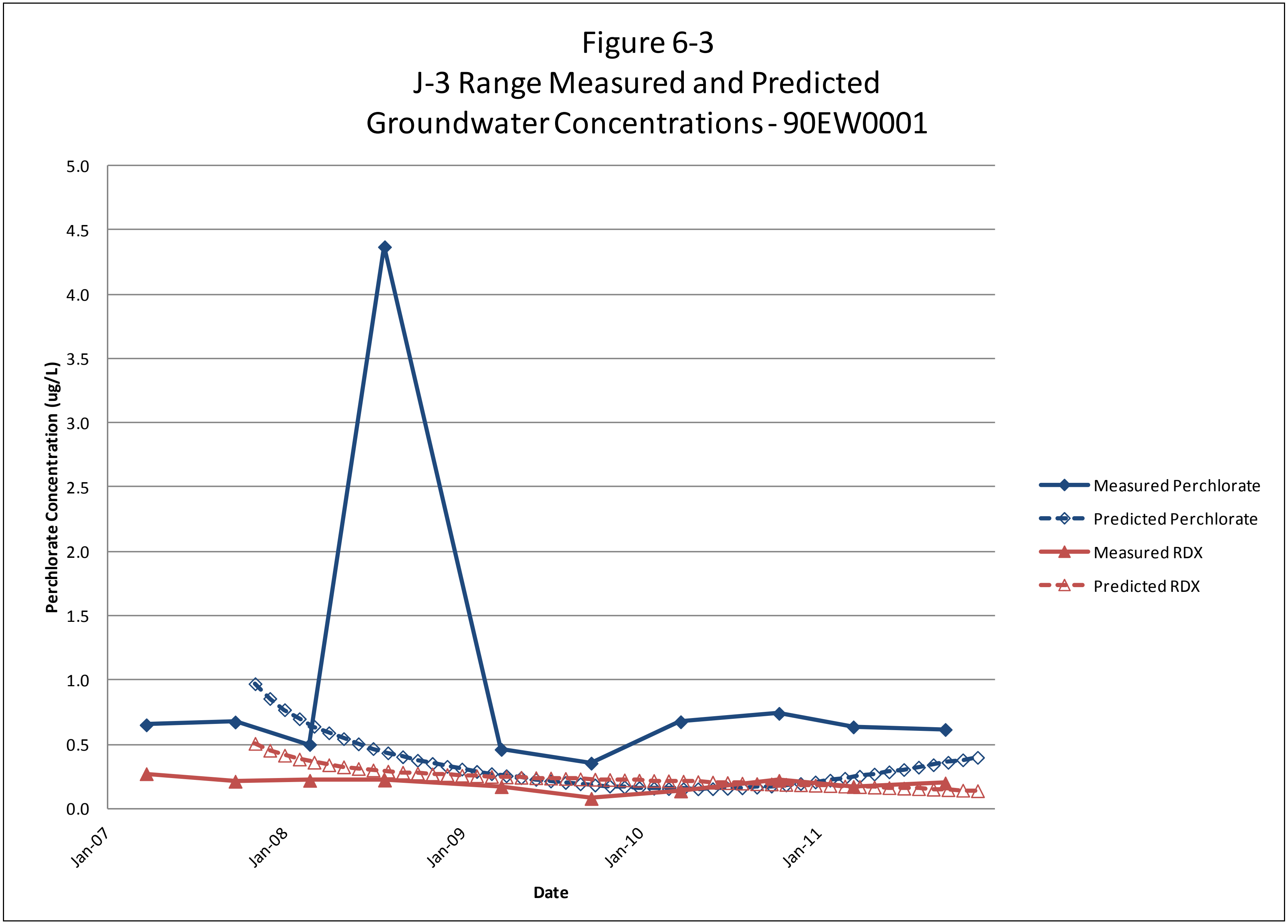
March 29, 2012 DWN: MTW CHKD: KJH



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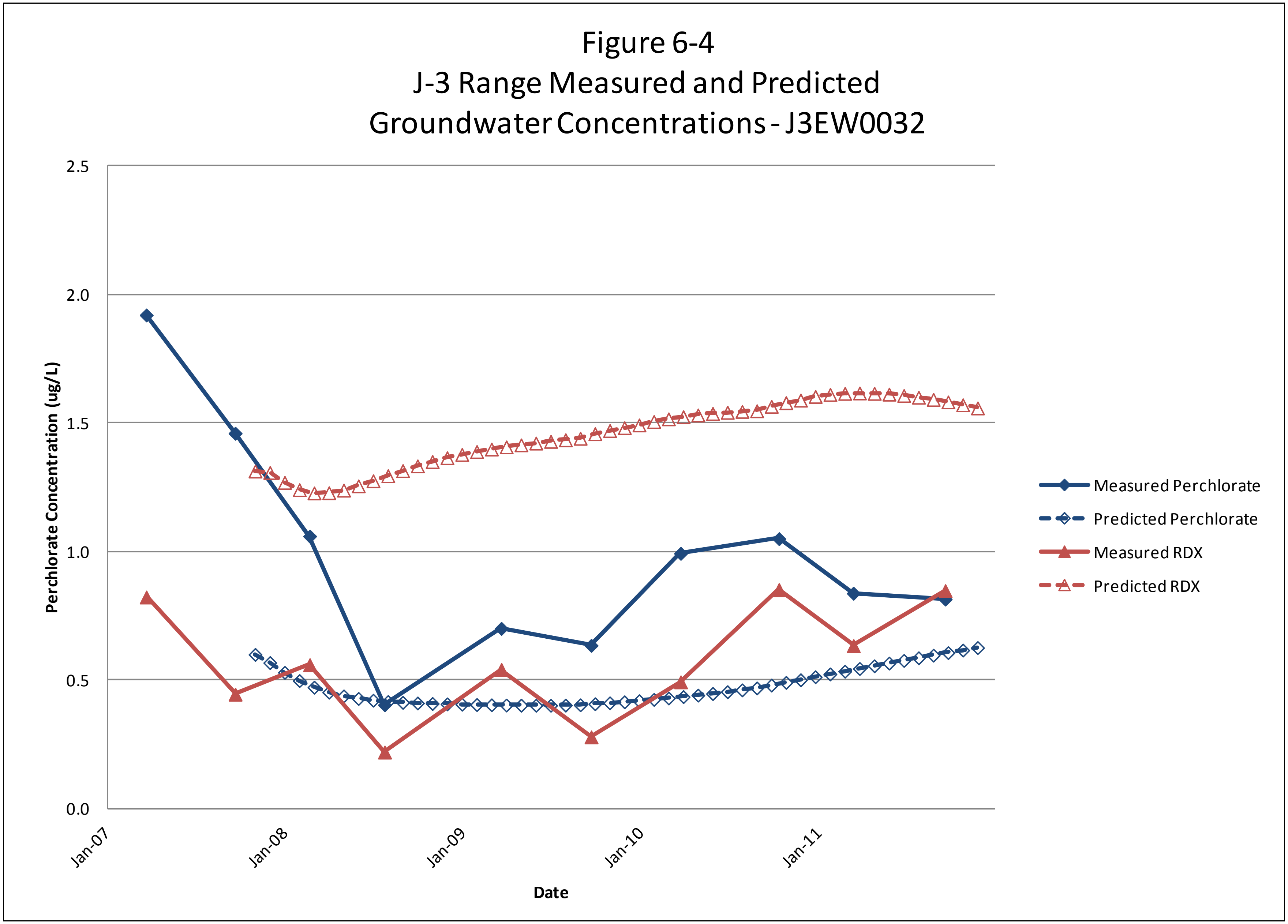
Figure 6-4
J-3 Range Measured and Predicted
Groundwater Concentrations - J3EW0032
Perchlorate Concentration (ug/L)
2.5
2.0
1.5
1.0
0.5
0.0
Jan-07
Jan-08
Jan-09
Jan-10
Jan-11
Date
Measured Perchlorate
Predicted Perchlorate
Measured RDX
Predicted RDX

Figure 6-5
J-3 Range Measured and Predicted
Groundwater Concentrations - J3EWIP1

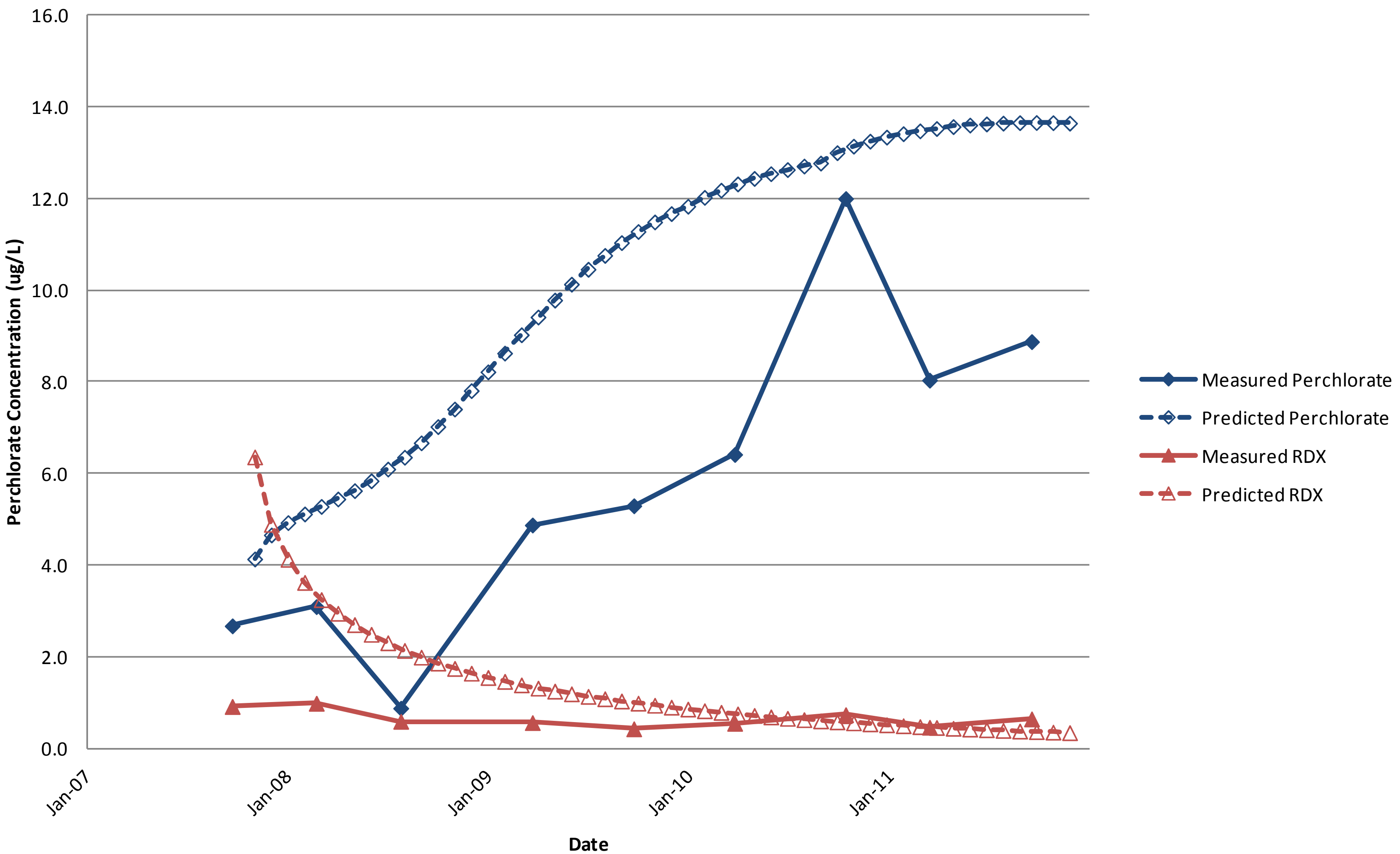

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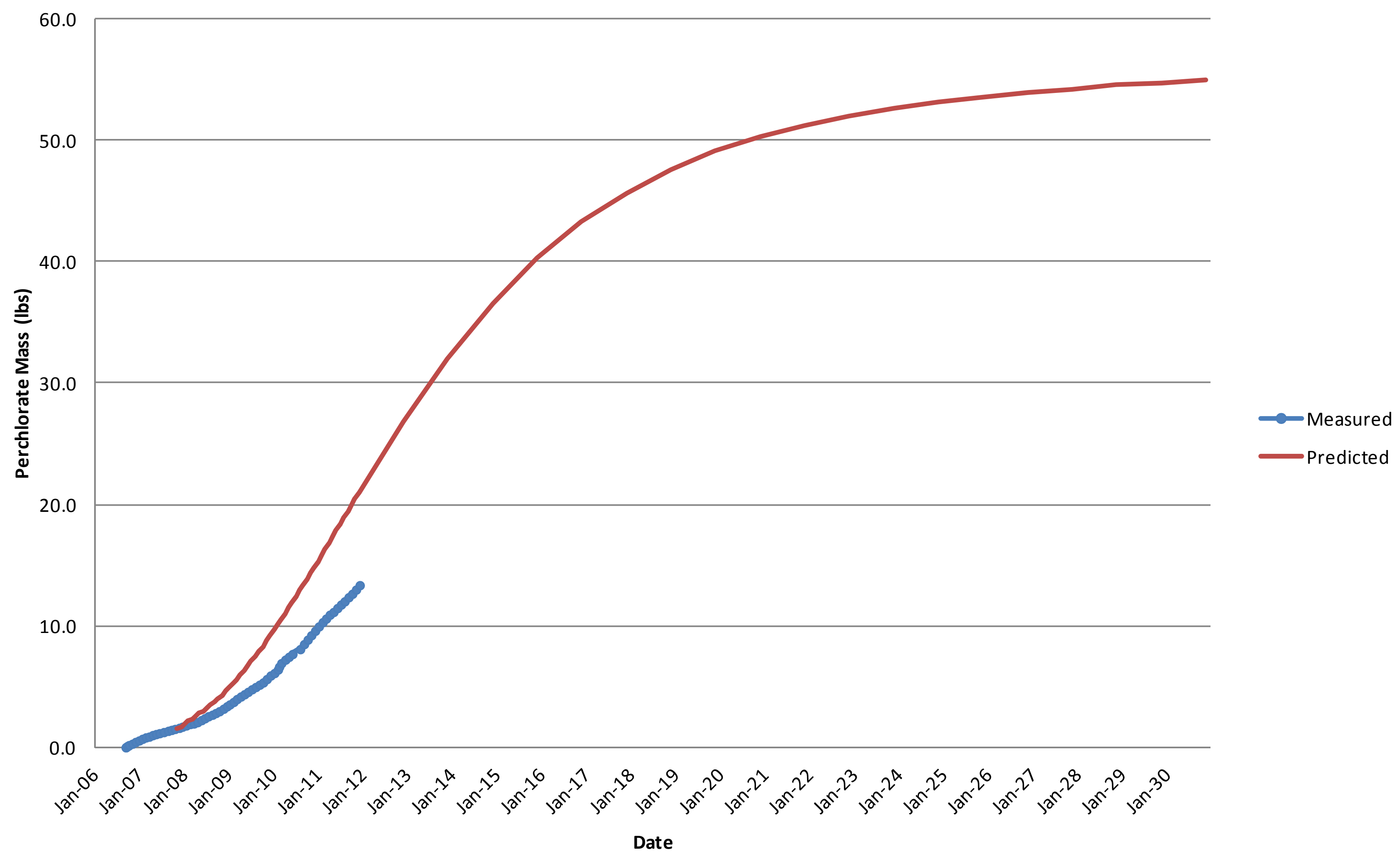
Figure 6-6
J-3 Range Measured and Predicted Groundwater Perchlorate Mass Removed



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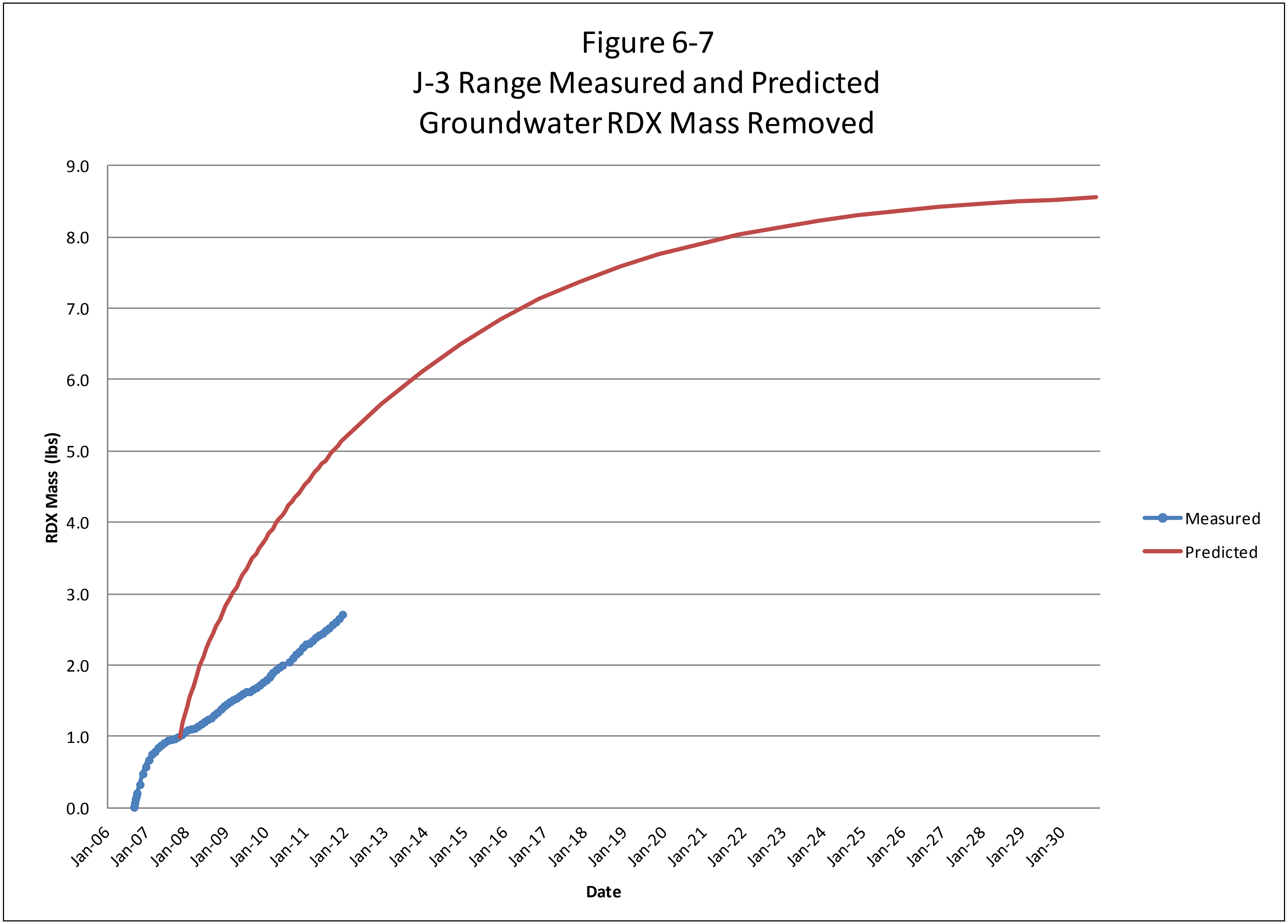

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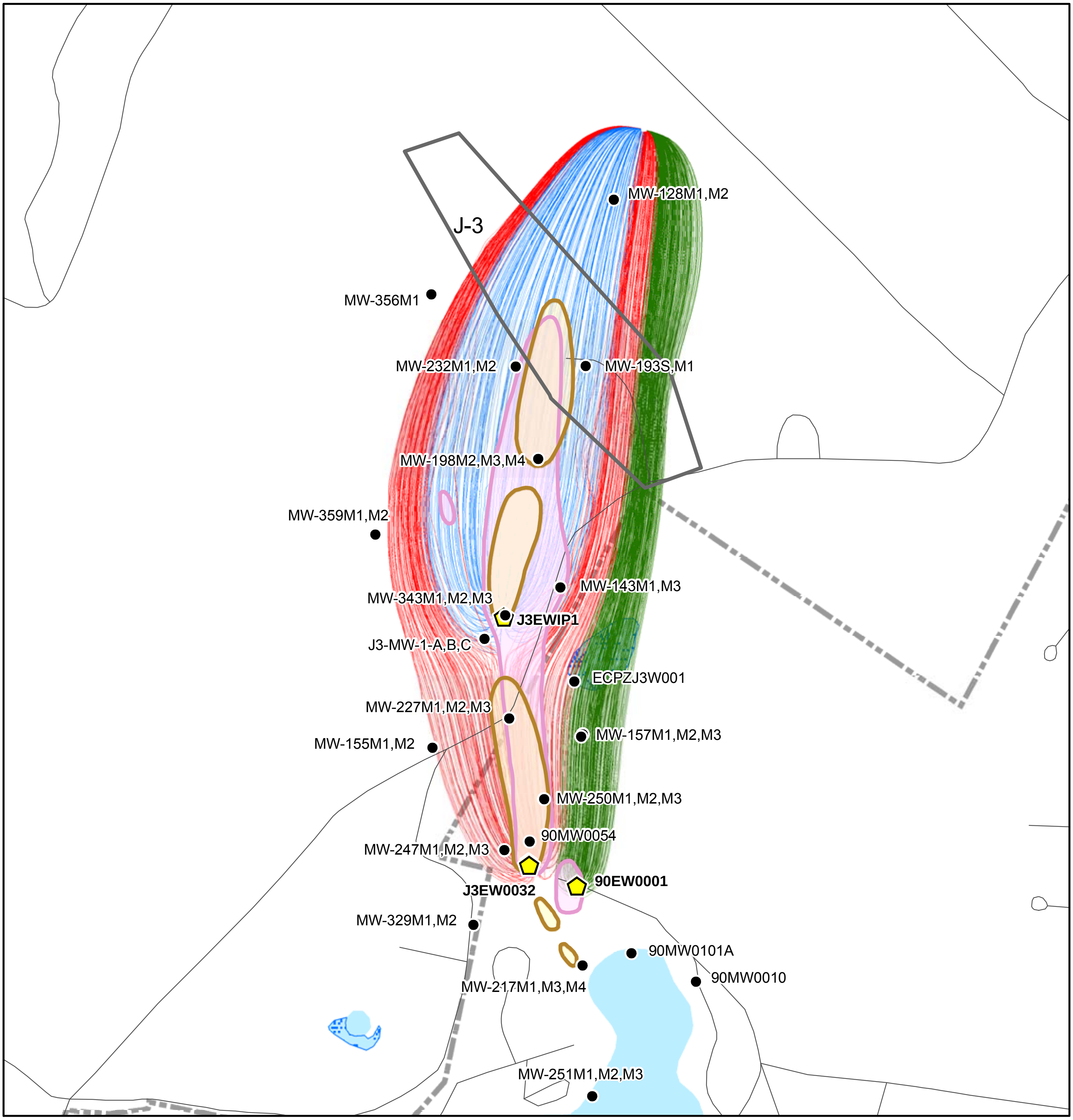
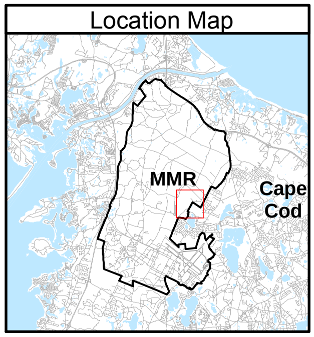


Legend

- Monitoring Well
- Extraction Well
- J3EW0032 Capture Zone Particle Tracks
- J3EW1P1 Capture Zone Particle Tracks
- 90EW0001 Capture Zone Particle Tracks
- Perchlorate Plume Shown to 2 µg/L (Fall 2011)
- RDX Plume Shown to 0.6 µg/L (Fall 2011)
- MMR Boundary

Location Map



N

0 800 Feet

TITLE

Model-Predicted Capture Zone for J-3 Range Groundwater

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FIGURE 6-8

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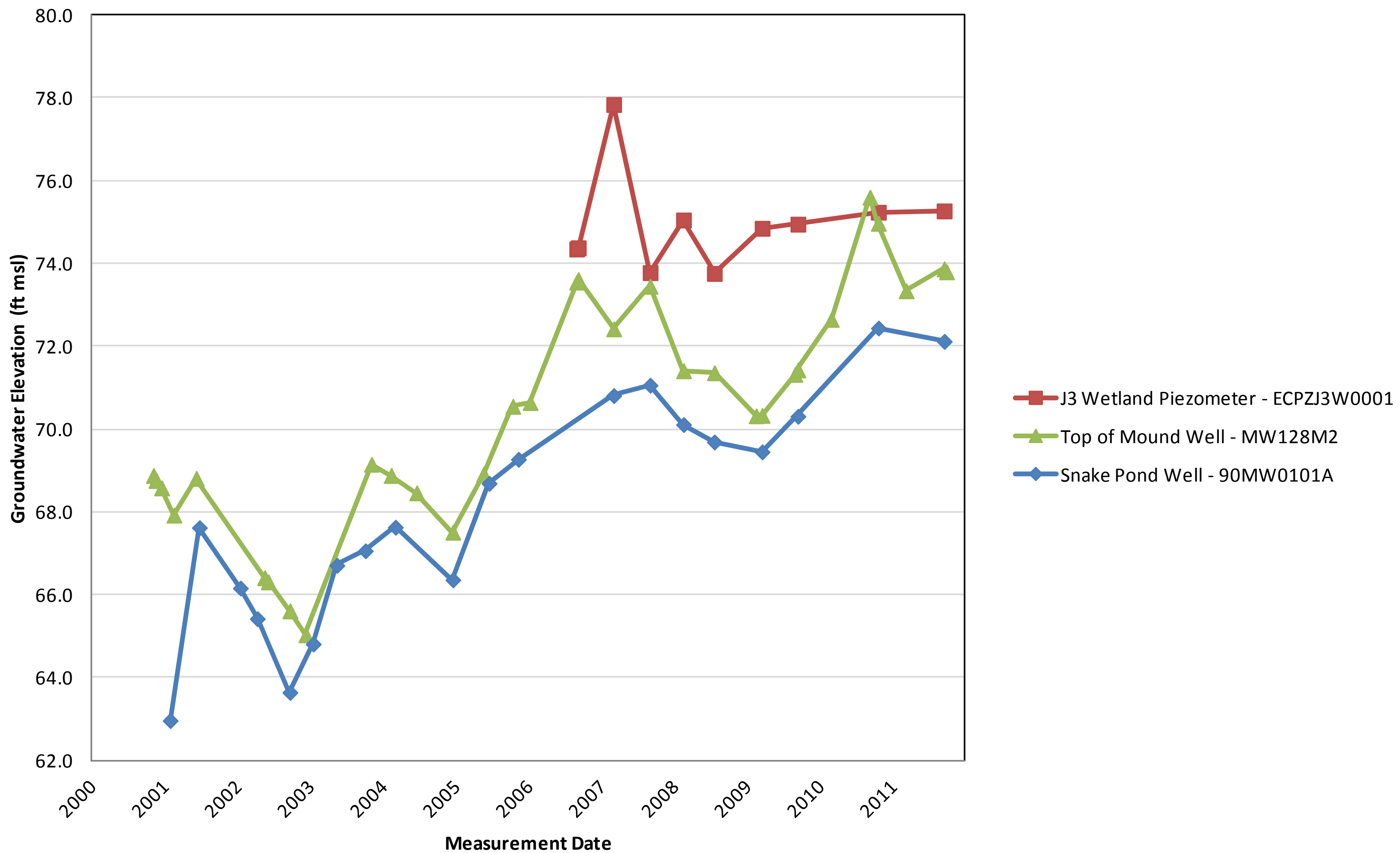
M:\MMR\2012\J3\AnnRpt\MXDs\Fig6-8_031312.mxd
March 13, 2012 DWN: MTW CHKD: KJH

Figure 7-1
J-3 Range Ecological
Monitoring Water Levels



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TABLES

Table 2-1
J3 RRA Groundwater Treatment System
Plant Maintenance, Availability, and Downtime Summary

Month	Availability		Maintenance / Downtime for Period		
	Period	Start-up to Date	Pump Hours	Event	Date/Action
Dec 2010	95.65%	94.16%	14.95 67.75 11.25	1. System shut down due a power interruption. Storm related. 2. System shut down due to a power interruption. Storm related. 3. Power supply interruption. Only EW-1P1 was shut down	1. System shutdown at 1840 h on 26 December 2010, system restarted at 0937 h on 27 December 2010. 2. System shutdown at 1020 h on 27 December 2010, system restarted at 0855 h on 28 December 2010. 3. System shutdown at 0103h on 20 December 2010, system restarted at 1218 h on 20 December 2010.
Jan 2011	97.86%	94.23%	10.03 39.27	1. Power supply interruption, 2 CGN wells down 2. Power supply interruption. EW-IP-1 tripped	1. System shutdown at 0458 h on 12 January 2011, system restarted at 0959 h on 12 January 2011. 2. System shutdown at 2101 h on 29 January 2011, system restarted at 1217h on 31 January 2011.
Feb 2011	100%	94.33%	0.00	No downtime	No downtime
Mar 2011	100%	94.43%	0.00	No downtime	No downtime
Apr 2011	80.72%	94.19%	157.30 47.67 203.00 6.55 2.00	1. Electrical / Control System Fault / Maintenance. Comm issue from FS-12 to MCC's in CGN, restored through Verizon 2. Power supply interruption, no alarms/power issues due to storm. 3. Power supply interruption. System tripped due to power failure. Reset wells at VFD's, 4. Power supply interruption. Lost comm's due to plant power failure 5. Power supply interruption. Lost comm's due to plant power failure	1. System shutdown at 0734 h on 2 April, system restarted at 1200 h on 4 April. 2. System shutdown at 0759 h on 17 April, system restarted at 0749 h on 18 April. 3. System shutdown at 1320 h on 22 April, system restarted at 0900 h on 25 April. 4. System shutdown at 0554 h on 28 April, system restarted at 0805h on 28 April. 5. System shutdown at 0833 h on 28 April, system restarted at 0913h on 28 April.
May 2011	100%	94.30%	0.00	No downtime	No downtime

Table 2-1
J3 RRA Groundwater Treatment System
Plant Maintenance, Availability, and Downtime Summary

Month	Availability		Maintenance / Downtime for Period		
	Period	Start-up to Date	Pump Hours	Event	Date/Action
Jun 2011	97.65%	94.35%	5.90 44.90	1. Power supply interruption. FS-12 off due to energy conservation setup, J3 tripped 2. Power supply interruption. EW0032 and EW0001 VFD faults	1. System shut down at 1247 h on 16 June and was restarted at 1445 h on 16 June. 2. System shut down at 1044h on 27 June and was restarted at 0911h on 28 June.
Jul 2011	87.68%	94.25%	53.30 203.90	1. Electrical/Control System Fault/Maintenance. Storage tank T-102 high level due to Comm issue from FS-12 to MCC's in CGN. Restored through Verizon. 2. Electrical/Control System Fault/Maintenance. Storage tank T-102 high level due to Comm issue from FS-12 to MCC's in CGN	1. System shutdown at 1904 h on 18 July and was restarted at 1250 h on 19 July. 2. System shutdown at 1321 h on 22 July and was restarted at 0919 h on 25 July.
Aug 2011	90.83%	94.18%	210.30 7.67	1. Shutdown in preparation for hurricane Irene. 2. Power supply interruption for EWIP1 only, no alarm	1. EW shutdown at 1142 h on 26 July and was restarted at 0948 h on 29 August. 2. System shutdown at 0245 h on 30 August and was restarted at 1045 h on 30 August.
Sep 2011	81.00%	93.97%	14.42 95.05 54.97 16.12 62.50 167.45	1. Power supply interruption. No alarm, EWIP-1 tripped. Possibly communication between VFD and PLC. 2. Power supply interruption due to power failure. FS-12 also down 3. Power supply interruption. No alarm, 90EW0001 shutdown 4. Power supply interruption. No alarm, J3EW0032 shutdown 5. Media Exchange. System off from IX resin changeout in vessels IX-001A and IX-001B 6. Power supply interruption due to Route 130 power line down in Sandwich	1. System shutdown at 1703 h on 1 September and was restarted at 0728 h on 2 September. 2. System shutdown at 0143 h on 5 September and was restarted at 0924 h on 6 September. 3. System shutdown at 0234 h on 17 September and was restarted at 0932 h on 19 September. 4. System shutdown at 0725 h on 19 September and was restarted at 0932 h. 5. System shutdown at 1605 h on 19 September and was restarted at 1255 h on 20 September. 6. System shutdown at 0010 h on 24 September and was restarted at 0759 h on 26 September.

Table 2-1
J3 RRA Groundwater Treatment System
Plant Maintenance, Availability, and Downtime Summary

<table>
<tr><th rowspan="2">Month</th><th colspan="2">Availability</th><th colspan="3">Maintenance / Downtime for Period</th></tr>
<tr><th>Period</th><th>Start-up to Date</th><th>Pump Hours</th><th>Event</th><th>Date/Action</th></tr>
<tr><td rowspan="3">Oct 2011</td><td rowspan="3">94.59%</td><td rowspan="3">93.98%</td><td>50.30</td><td>1. Power supply interruption. CGN wells went down</td><td>1. System shut down at 0909h on 1 Oct and was restarted at 1018 h on 2 Oct.</td></tr>
<tr><td>6.50</td><td>2. Power supply interruption. No alarm.</td><td>2. System shut down at 1343 h on 20 Oct and was restarted at 1533.</td></tr>
<tr><td>64.00</td><td>3. Other shut down. FS-12 off, J3 was running, no alarms</td><td>3. System shut down at 0930 h on 30 Oct and was restarted at 0650 h on 31 Oct.</td></tr>
<tr><td>Nov 2011</td><td>100%</td><td>94.07%</td><td>0.00</td><td>No downtime</td><td>No downtime</td></tr>
<tr><td colspan="3">Cumulative % Available</td><td>Pump Hours Down</td><td colspan="2"></td></tr>
<tr><td rowspan="4"></td><td rowspan="4">93.85%</td><td rowspan="4">94.07%</td><td>210.30</td><td colspan="2">Downtime During Reporting Period: Planned Shutdowns</td></tr>
<tr><td>1415.74</td><td colspan="2">Downtime During Reporting Period: Unplanned Shutdowns</td></tr>
<tr><td>1617.04</td><td colspan="2">Total Downtime Hours During Reporting Period</td></tr>
<tr><td>8171.69</td><td colspan="2">Total Downtime Hours Since System Startup</td></tr>
</table>

Table 3-1
J-3 RRA System Sampling Locations
and Parameters for Operational Monitoring

Parameter	System Influent	J3 MID-1	J3 MID-2	System Effluent
Contaminants of Concern				
Perchlorate	monthly	monthly	None, until a detect at Post Lead IX	monthly
Explosives	monthly	none	monthly	monthly
Geochemistry				
Metals, Modified; Hardness	TBD	TBD	TBD	TBD
Chloride; Sulfate; Alkalinity	TBD	TBD	TBD	TBD
Ammonia; Nitrate/Nitrite; Phosphorus	TBD	TBD	TBD	TBD
Total Organic Carbon	TBD	TBD	TBD	TBD
Total Suspended Solids (TSS)	TBD	TBD	TBD	TBD
Field Measurements				
Dissolved Oxygen	X	X	X	X
pH	X	X	X	X
Specific Conductivity	X	X	X	X
Temperature	X	X	X	X
Oxygen Reduction Potential	X	X	X	X
Turbidity	X	X	X	X

Notes:

1. X = Field measurements will be taken concurrent with all sampling events
2. TBD = To be determined in order to evaluate system operations
3. Sampling locations, parameters and frequency will be continuously evaluated and any proposed changes will be submitted for review and approval prior to implementation

Table 3-2
J-3 GW RRA ETR System
Analytical Results

Date	Time	Sample Port	Laboratory Analyses			Field Parameters					
			Explosives		Perchlorate (µg/L)	Temp (°C)	SpC (µS/cm)	DO (mg/L)	pH	ORP (mV)	Turb. (ntu)
			RDX (µg/L)	HMX (µg/L)							
12/6/2010	14:25	J3-INF-51A	0.671	0.641	5.38	9.37	57	11.45	6.03	177.3	0.00
12/6/2010	14:30	J3-MID-1-51A	NS	NS	ND	9.53	61	11.38	5.88	180	0.00
12/6/2010	14:35	J3-MID-2-51A	ND	ND	NS	9.10	62	11.14	5.89	179.1	0.00
12/6/2010	14:40	J3-EFF-51A	ND	ND	ND	9.41	63	11.02	5.95	177.9	0.00
1/10/2011	15:30	J3-INF-52A	ND	ND	4.84	9.07	63	11.44	5.62	220.9	0.00
1/10/2011	15:35	J3-MID-1-52A	NS	NS	ND	9.29	63	11.5	5.46	230	0.00
1/10/2011	15:40	J3-MID-2-52A	ND	ND	NS	9.11	65	10.94	5.48	226.3	0.00
1/10/2011	15:45	J3-EFF-52A	ND	ND	ND	9.16	63	11.2	5.53	222.9	0.00
2/6/2011	10:50	J3-INF-53A	0.536	0.525	4.58	9.34	82	11.43	5.62	170.9	0.00
2/6/2011	10:55	J3-MID-1-53A	NS	NS	ND	9.29	65	11.47	5.46	174.7	0.00
2/6/2011	11:00	J3-MID-2-53A	ND	ND	NS	9.19	64	11.14	5.48	174	0.00
2/6/2011	11:05	J3-EFF-53A	ND	ND	ND	9.16	64	11.12	5.53	170.6	0.00
3/9/2011	14:05	J3-INF-54A	0.669	0.708	4.59	9.44	51	11.74	7.5	187	0.00
3/9/2011	14:10	J3-MID-1-54A	NS	NS	ND	9.38	49	11.73	6.85	216.3	0.00
3/9/2011	14:15	J3-MID-2-54A	ND	ND	NS	9.41	50	11.57	6.27	217.4	0.00
3/9/2011	14:20	J3-EFF-54A	ND	ND	ND	9.35	49	11.7	6.24	211.4	0.00
4/11/2011	15:05	J3-INF-55A	0.586	0.512	4.04	10.00	72	11.28	6.03	186.1	0.00
4/11/2011	15:10	J3-MID-1-55A	NS	NS	ND	9.74	72	11.41	5.97	187.4	0.00
4/11/2011	15:15	J3-MID-2-55A	ND	ND	NS	9.77	72	11.01	5.87	189.8	0.00
4/11/2011	15:20	J3-EFF-55A	ND	ND	ND	9.77	72	11.05	5.92	188.8	0.00
5/9/2011	15:30	J3-INF-56A	0.335	0.286	4.33	10.08	74	10.79	5.95	247.8	0.00
5/9/2011	15:35	J3-MID-1-56A	NS	NS	ND	10.00	73	10.99	5.89	260.4	0.00
5/9/2011	15:40	J3-MID-2-56A	ND	ND	NS	10.01	74	10.96	5.87	247.4	0.00
5/9/2011	15:45	J3-EFF-56A	ND	ND	ND	10.02	74	10.72	5.91	255.3	0.00
6/6/2011	14:30	J3-INF-57A	0.6	0.403	4.26	10.65	75	11.1	6.02	196.2	0.00
6/6/2011	14:35	J3-MID-1-57A	NS	NS	ND	10.27	74	11.02	5.93	196.8	0.00
6/6/2011	14:40	J3-MID-2-57A	ND	ND	NS	10.37	74	10.66	5.81	200.5	0.00
6/6/2011	14:45	J3-EFF-57A	ND	ND	ND	10.39	74	10.6	5.89	200	0.00
7/13/2011	11:20	J3-INF-58A	0.55	0.435	4.44	11.12	81	10.7	6.29	186.1	0.00
7/13/2011	11:25	J3-MID-1-58A	NS	NS	ND	10.69	80	10.79	6.07	186.5	0.00
7/13/2011	11:30	J3-MID-2-58A	ND	ND	NS	10.69	80	10.41	5.84	189	0.00
7/13/2011	11:35	J3-EFF-58A	ND	ND	ND	10.73	80	10.43	5.87	187.9	0.00
8/8/2011	10:20	J3-INF-59A	0.703	0.554	4.86	10.84	76	10.99	6.08	170.7	0.00
8/8/2011	10:25	J3-MID-1-59A	NS	NS	**0.35**	10.45	76	11.08	5.98	173.2	0.00
8/8/2011	10:30	J3-MID-2-59A	ND	ND	NS	10.54	76	10.62	5.86	176.8	0.00
8/8/2011	10:35	J3-EFF-59A	ND	ND	ND	10.69	76	10.63	5.92	176.4	0.00
9/8/2011	9:00	J3-INF-60A	0.631	0.547	4.85	10.78	81	11.91	6.01	95.1	0.00
9/8/2011	9:05	J3-MID-1-60A	NS	NS	**0.35**	10.41	80	12.19	5.93	99.7	0.00
9/8/2011	9:10	J3-MID-2-60A	ND	ND	NS	10.50	80	11.84	5.84	107	0.00
9/8/2011	9:15	J3-EFF-60A	ND	ND	ND	10.51	80	11.85	5.89	113	0.00

Table 3-2
J-3 GW RRA ETR System
Analytical Results

Date	Time	Sample Port	Laboratory Analyses			Field Parameters					
			Explosives		Perchlorate (µg/L)	Temp (°C)	SpC (µS/cm)	DO (mg/L)	pH	ORP (mV)	Turb. (ntu)
			RDX (µg/L)	HMX (µg/L)							
10/11/2011	15:20	J3-INF-61A	0.694	0.547	5.08	10.35	75	11.27	6.12	158.6	0.00
10/11/2011	15:25	J3-MID-1-61A	NS	NS	ND	10.12	75	11.12	5.95	160.7	0.00
10/11/2011	15:30	J3-MID-2-61A	ND	ND	NS	10.14	75	10.79	5.91	161.8	0.00
10/11/2011	15:35	J3-EFF-61A	ND	ND	ND	10.19	75	10.87	5.99	161.6	0.00
11/9/2011	9:00	J3-INF-62A	0.824	0.445	5.18	9.93	85	11	7.29	165.3	0.00
11/9/2011	9:05	J3-MID-1-62A	NS	NS	ND	9.80	78	10.99	6.89	171.4	0.00
11/9/2011	9:10	J3-MID-2-62A	ND	ND	NS	9.81	78	10.61	6.31	178.2	0.00
11/9/2011	9:15	J3-EFF-62A	ND	ND	ND	9.78	78	10.67	6.15	179	0.00

LEGEND

Perchlorate = ionic concentration
RDX = Hexahydro-1,3,5-Trinitro-1,3,5-Triazine
HMX = Octahydro-1,3,5,7-Tetranitro-1,3,5,7-Tetrazocine

NS = not sampled
J = estimated value
ND = RDX & HMX not detected above 0.25 µg/L;Perchlorate not detected above 0.35 ug/L

Temp = temperature
SpC = specific conductivity
DO = dissolved oxygen
ORP = oxidation reduction potential
Turb = turbidity
pH = pH

°C = degrees Celsius
µS/cm = microsiemens per centimeter
mg/L = milligrams per liter (parts per million)
mV = millivolts
ntu = nephelometric turbidity units
Breakthrough Detected

J3-INF = System Influent
J3-MID-1 = IX Effluent
J3-MID-2 = GAC Midfluent
J3-EFF = System Effluent

Where duplicate sample results were available, the result presented is the average of the original and duplicate samples.

Table 4-1
J-3 Range Plume Water Level Monitoring Network

Location	Northing (UTM - meters)	Easting (UTM - meters)	Top of Casing Elevation (ft msl)	Screen Top Elevation (ft msl)	Screen Bottom Elevation (ft msl)
90EW0001	4,616,322	373,423	82.69	5.06	-55.67
J3EW0032	4,616,357	373,341	80.50	-17.86	-67.86
J3EWIP1	4,616,783	373,298	155.79	0.29	-39.71
90MW0010	4,616,157	373,628	78.79	67.70	57.70
90MW0054	4,616,398	373,342	83.42	-23.24	-28.24
90MW0101A	4,616,206	373,517	71.56	-40.48	-45.29
ECPZJ3W001	4,616,672	373,419	77.84	75.00	71.00
J3-MW-1-A	4,616,745	373,264	160.18	32.15	22.15
J3-MW-1-B	4,616,746	373,264	160.18	-14.84	-24.84
J3-MW-1-C	4,616,745	373,265	160.18	-42.84	-52.84
MW-128M2	4,617,499	373,487	157.16	53.74	43.74
MW-128M1	4,617,500	373,487	157.06	13.74	3.74
MW-143M3	4,616,834	373,395	101.38	-5.17	-10.17
MW-143M1	4,616,834	373,395	101.37	-42.17	-52.17
MW-155M2	4,616,559	373,176	95.61	51.01	41.01
MW-155M1	4,616,559	373,176	95.51	-27.99	-37.99
MW-157M3	4,616,578	373,431	81.82	11.80	1.80
MW-157M2	4,616,582	373,433	80.95	-28.67	-38.67
MW-157M1	4,616,582	373,433	80.93	-72.67	-82.67
MW-193M1	4,617,213	373,439	100.23	43.21	38.21
MW-193S	4,617,214	373,439	100.11	68.21	63.21
MW-198M4	4,617,054	373,357	88.52	19.57	14.57
MW-198M3	4,617,054	373,357	88.44	-10.43	-15.43
MW-198M2	4,617,054	373,357	88.51	-30.43	-35.43
MW-217M4	4,616,185	373,433	69.44	1.71	-3.29
MW-217M3	4,616,185	373,433	69.42	-31.29	-36.29
MW-217M1	4,616,185	373,433	69.48	-78.29	-83.29
MW-227M3	4,616,609	373,307	118.86	54.29	44.29
MW-227M2	4,616,609	373,307	118.84	9.29	-0.71
MW-227M1	4,616,609	373,307	118.86	-10.71	-20.71
MW-232M2	4,617,213	373,319	108.28	47.73	42.73
MW-232M1	4,617,213	373,318	108.28	31.23	26.23
MW-247M3	4,616,383	373,299	87.20	-7.24	-17.24
MW-247M2	4,616,383	373,299	87.23	-37.24	-47.24
MW-247M1	4,616,383	373,299	87.24	-92.24	-102.24
MW-250M3	4,616,470	373,367	75.20	-0.41	-10.41
MW-250M2	4,616,470	373,367	75.22	-50.41	-60.41
MW-250M1	4,616,471	373,367	75.20	-90.41	-100.41
MW-251M3	4,615,961	373,450	68.31	-14.29	-19.29
MW-251M2	4,615,961	373,450	68.42	-29.27	-39.27
MW-251M1	4,615,961	373,450	68.54	-59.17	-64.17
MW-329M2	4,616,255	373,246	91.46	-57.99	-67.99
MW-329M1	4,616,255	373,246	91.55	-87.90	-97.90
MW-343M3	4,616,786	373,300	160.41	50.99	40.99
MW-343M2	4,616,786	373,300	160.41	-5.71	-10.71
MW-343M1	4,616,786	373,300	160.41	-53.72	-63.72
MW-356M1	4,617,337	373,174	170.40	-14.31	-24.31
MW-359M2	4,616,924	373,077	162.43	14.23	4.23
MW-359M1	4,616,924	373,077	162.53	-21.41	-31.41
537-0107	4,617,554	373,685	167.08	79.95	60.41

Notes:

Bolded well names were used to provide water levels for the interpreted piezometric surface.

ft - feet

msl - mean sea level (equivalent to zero elevation NGVD29)

Table 4-2
J-3 Range Plume Water Level Results and Analysis

Monitoring Well Geometries				Prior to System Startup Groundwater Elevations	2010 Groundwater Elevations	2011 Groundwater Elevations	2010 to 2011 Water Level Changes
Location	Top of Casing Elevation (ft msl)	Screen Top Elevation (ft msl)	Screen Bottom Elevation (msl ft)	8/31/2006 (ft msl)	10/25/2010 (ft msl)	9/21/2011 (ft msl)	Change (ft) 10/25/10 to 9/21/11
90EW0001	82.69	5.06	(55.67)	72.44	73.29	72.44	(0.85)
J3EW0032	80.50	(17.86)	(67.86)	71.83	72.49	71.49	(1.00)
J3EWIP1	155.79	0.29	(39.71)	72.77	72.99	71.97	(1.02)
90MW0010	78.79	67.70	57.70	Not Measured	72.67	71.97	(0.70)
90MW0054	83.42	(23.24)	(28.24)	Not Measured	73.12	72.37	(0.75)
90MW0101A	71.56	(40.48)	(45.29)	Not Measured	72.44	72.12	(0.32)
ECPZJ3W001	77.84	75.00	71.00	Not Measured	75.24	75.27	0.03
J3-MW-1-A	160.18	32.15	22.15	72.71	73.73	72.93	(0.80)
J3-MW-1-B	160.18	(14.84)	(24.84)	72.74	73.74	72.90	(0.84)
J3-MW-1-C	160.18	(42.84)	(52.84)	72.60	73.76	72.95	(0.81)
MW-128M2	157.16	53.74	43.74	73.55	74.97	73.87	(1.10)
MW-128M1	157.06	13.74	3.74	73.54	74.94	73.86	(1.08)
MW-143M3	101.38	(5.17)	(10.17)	72.78	73.89	73.06	(0.83)
MW-143M1	101.37	(42.17)	(52.17)	72.76	73.86	73.05	(0.81)
MW-155M2	95.61	51.01	41.01	72.24	73.47	72.70	(0.77)
MW-155M1	95.51	(27.99)	(37.99)	72.22	73.46	72.70	(0.76)
MW-157M3	81.82	11.80	1.80	72.80	74.04	73.30	(0.74)
MW-157M2	80.95	(28.67)	(38.67)	72.17	73.37	72.65	(0.72)
MW-157M1	80.93	(72.67)	(82.67)	72.15	73.38	72.63	(0.75)
MW-193M1	100.23	43.21	38.21	Not Measured	74.72	73.76	(0.96)
MW-193S	100.11	68.21	63.21	Not Measured	74.72	73.76	(0.96)
MW-198M4	88.52	19.57	14.57	73.23	74.49	73.59	(0.90)
MW-198M3	88.44	(10.43)	(15.43)	73.23	74.47	73.56	(0.91)
MW-198M2	88.51	(30.43)	(35.43)	73.22	74.46	73.55	(0.91)
MW-217M4	69.44	1.71	(3.29)	Not Measured	Submerged	Submerged	N/A
MW-217M3	69.42	(31.29)	(36.29)	Not Measured	Submerged	Submerged	N/A
MW-217M1	69.48	(78.29)	(83.29)	Not Measured	Submerged	Submerged	N/A
MW-227M3	118.86	54.29	44.29	72.43	73.70	72.93	(0.77)
MW-227M2	118.84	9.29	(0.71)	72.44	73.69	72.92	(0.77)
MW-227M1	118.86	(10.71)	(20.71)	72.45	73.69	72.92	(0.77)
MW-232M2	108.28	47.73	42.73	Not Measured	74.72	73.75	(0.97)
MW-232M1	108.28	31.23	26.23	Not Measured	74.73	73.76	(0.97)

Table 4-2
J-3 Range Plume Water Level Results and Analysis

Monitoring Well Geometries				Prior to System Startup Groundwater Elevations	2010 Groundwater Elevations	2011 Groundwater Elevations	2010 to 2011 Water Level Changes
Location	Top of Casing Elevation (ft msl)	Screen Top Elevation (ft msl)	Screen Bottom Elevation (msl ft)	8/31/2006 (ft msl)	10/25/2010 (ft msl)	9/21/2011 (ft msl)	Change (ft) 10/25/10 to 9/21/11
MW-247M3	87.20	(7.24)	(17.24)	72.01	73.25	72.50	(0.75)
MW-247M2	87.23	(37.24)	(47.24)	71.96	73.25	72.51	(0.74)
MW-247M1	87.24	(92.24)	(102.24)	72.03	73.23	72.49	(0.74)
MW-250M3	75.20	(0.41)	(10.41)	72.07	73.35	72.62	(0.73)
MW-250M2	75.22	(50.41)	(60.41)	72.12	73.34	72.61	(0.73)
MW-250M1	75.20	(90.41)	(100.41)	72.07	73.35	72.61	(0.74)
MW-251M3	68.31	(14.29)	(19.29)	Not Measured	Submerged	Submerged	N/A
MW-251M2	68.42	(29.27)	(39.27)	Not Measured	Submerged	Submerged	N/A
MW-251M1	68.54	(59.17)	(64.17)	Not Measured	Submerged	Submerged	N/A
MW-329M2	91.46	(57.99)	(67.99)	72.45	73.15	72.41	(0.74)
MW-329M1	91.55	(87.90)	(97.90)	72.36	73.14	72.42	(0.72)
MW-343M3	160.41	50.99	40.99	73.31	73.76	72.96	(0.80)
MW-343M2	160.41	(5.71)	(10.71)	73.30	73.48	72.68	(0.80)
MW-343M1	160.41	(53.72)	(63.72)	73.30	73.97	73.13	(0.84)
MW-356M1	170.40	(14.31)	(24.31)	Not Measured	74.89	73.85	(1.04)
MW-359M2	162.43	14.23	4.23	73.56	74.18	73.32	(0.86)
MW-359M1	162.53	(21.41)	(31.41)	73.51	74.24	73.38	(0.86)
537-0107	167.08	79.95	60.41		74.94	73.81	(1.13)

Notes:
ft - feet
msl - mean sea level (equivalent to zero elevation NGVD29)

Table 4-3
J-3 Range Plume Water Level Results and Vertical Gradients

Monitoring Well Geometries				Ambient Conditions		2010 Groundwater Elevations		2011 Groundwater Elevations	
Location	Top of Casing Elevation (ft msl)	Screen Top Elevation (ft msl)	Screen Bottom Elevation (ft msl)	8/31/2006 (ft msl)	Vertical Gradient	10/25/2010 (ft msl)	Vertical Gradient	9/21/2011 (ft msl)	Vertical Gradient
MW-128M2	157.16	53.74	43.74	73.55		74.97		73.87	
MW-128M1	157.06	13.74	3.74	73.54	-0.0002	74.94	-0.0008	73.86	-0.0003
MW-193S	100.11	68.21	63.21	Not Measured		74.72		73.76	
MW-193M1	100.23	43.21	38.21	Not Measured		74.72	0.0000	73.76	0.0000
MW-232M2	108.28	47.73	42.73	Not Measured		74.72		73.75	
MW-232M1	108.28	31.23	26.23	Not Measured		74.73	0.0006	73.76	0.0006
MW-198M4	88.52	19.57	14.57	73.23		74.49		73.59	
MW-198M3	88.44	(10.43)	(15.43)	73.23	0.0000	74.47	-0.0007	73.56	-0.0010
MW-198M2	88.51	(30.43)	(35.43)	73.22	-0.0005	74.46	-0.0005	73.55	-0.0005
MW-359M2	162.43	14.23	4.23	73.56		74.18		73.32	
MW-359M1	162.53	(21.41)	(31.41)	73.51	-0.0014	74.24	0.0017	73.38	0.0017
MW-143M3	101.38	(5.17)	(10.17)	72.78		73.89		73.06	
MW-143M1	101.37	(42.17)	(52.17)	72.76	-0.0005	73.86	-0.0008	73.05	-0.0003
J3EWIP1	155.79	0.29	(39.71)	72.77		72.99		71.97	
MW-343M3	160.41	50.99	40.99	73.31		73.76		72.96	
MW-343M2	160.41	(5.71)	(10.71)	73.30	-0.0002	73.48	-0.0052	72.68	-0.0052
MW-343M1	160.41	(53.72)	(63.72)	73.30	0.0000	73.97	0.0097	73.13	0.0089
J3-MW-1-A	160.18	32.15	22.15	72.71		73.73		72.93	
J3-MW-1-B	160.18	(14.84)	(24.84)	72.74	0.0006	73.74	0.0002	72.90	-0.0006
J3-MW-1-C	160.18	(42.84)	(52.84)	72.60	-0.0050	73.76	0.0007	72.95	0.0018
MW-227M3	118.86	54.29	44.29	72.43		73.70		72.93	
MW-227M2	118.84	9.29	(0.71)	72.44	0.0002	73.69	-0.0002	72.92	-0.0002
MW-227M1	118.86	(10.71)	(20.71)	72.45	0.0005	73.69	0.0000	72.92	0.0000
MW-157M3	81.82	11.80	1.80	72.80		74.04		73.30	
MW-157M2	80.95	(28.67)	(38.67)	72.17	-0.0156	73.37	-0.0166	72.65	-0.0161
MW-157M1	80.93	(72.67)	(82.67)	72.15	-0.0005	73.38	0.0002	72.63	-0.0005
MW-155M2	95.61	51.01	41.01	72.24		73.47		72.70	
MW-155M1	95.51	(27.99)	(37.99)	72.22	-0.0003	73.46	-0.0001	72.70	0.0000
MW-250M3	75.20	(0.41)	(10.41)	72.07		73.35		72.62	
MW-250M2	75.22	(50.41)	(60.41)	72.12	0.0010	73.34	-0.0002	72.61	-0.0002
MW-250M1	75.20	(90.41)	(100.41)	72.07	-0.0013	73.35	0.0002	72.61	0.0000
MW-247M3	87.20	(7.24)	(17.24)	72.01		73.25		72.50	

Table 4-3
J-3 Range Plume Water Level Results and Vertical Gradients

Monitoring Well Geometries				Ambient Conditions		2010 Groundwater Elevations		2011 Groundwater Elevations	
Location	Top of Casing Elevation (ft msl)	Screen Top Elevation (ft msl)	Screen Bottom Elevation (ft msl)	8/31/2006 (ft msl)	Vertical Gradient	10/25/2010 (ft msl)	Vertical Gradient	9/21/2011 (ft msl)	Vertical Gradient
MW-247M2	87.23	(37.24)	(47.24)	71.96	-0.0017	73.25	0.0000	72.51	0.0003
MW-247M1	87.24	(92.24)	(102.24)	72.03	0.0013	73.23	-0.0004	72.49	-0.0004
MW-329M2	91.46	(57.99)	(67.99)	72.45		73.15		72.41	
MW-329M1	91.55	(87.90)	(97.90)	72.36	-0.0030	73.14	-0.0003	72.42	0.0003

Notes:
ft - feet
msl - mean sea level (equivalent to zero elevation NGVD29)
positive gradient denotes upward flow
negative gradient denotes downward flow

Table 5-1
J-3 Range 2011 Groundwater Chemical Monitoring Network

Location	Northing Coordinate (N83UTM m)	Easting Coordinate (N83UTM m)	Surface Elevation (ft msl)	Screen Interval (ft msl)	Rationale for Location	Frequency (a)	Parameters (b)
90EW0001	4,616,322	373,423	88.16	5.06 to -55.67	Extraction well for J-3 ETI System, used to help calculate and confirm mass removal by the system.	S	Explosives, Perchlorate
J3EW00032	4,616,357	373,341	84.14	-17.86 to -67.86	Extraction well for J-3 ETI System, used to help calculate and confirm mass removal by the system.	S	Explosives, Perchlorate
J3EWIP1	4,616,782	373,297	160.06	7.06 to -32.94	Extraction well for J-3 ETI System, used to help calculate and confirm mass removal by the system.	S	Explosives, Perchlorate
90MP0059B	4,616,265	373,495	75.90	-40.49 to -42.99	Monitor groundwater at the core of the RDX.	A	Explosives
90MW0104B	4,615,278	373,708	79.48	-35.52 to -40.52	Sentry well downgradient of RDX and perchlorate plumes.	B	Explosives, Perchlorate
90MW0104C	4,615,276	373,709	79.70	-5.11 to -10.11	Sentry well downgradient of RDX and perchlorate plumes.	B	Explosives, Perchlorate
90PZ0204	4,616,150	373,408	74.62	-5.38 to -10.38	Monitor groundwater at the western boundary of the RDX plume and leading edge of the perchlorate plume.	A	Explosives, Perchlorate
90PZ0211	4,616,232	373,376	74.52	-5.48 to -35.48	Monitor the leading edge of the RDX and perchlorate plumes.	A	Explosives, Perchlorate
J3-MW-1-B	4,616,746	373,264	160.77	-14.84 to -15.84	Monitor lower boundary of RDX and perchlorate plumes.	A	Explosives, Perchlorate
J3-MW-1-C	4,616,745	373,264	160.77	-42.84 to -52.84	Monitor lower boundary of RDX and perchlorate plumes.	A	Explosives, Perchlorate
MW-142M2	4,616,788	373,385	112.26	-27.74 to -37.74	Monitor the core of the RDX and perchlorate plumes.	A	Explosives, Perchlorate
MW-143M1	4,616,834	373,395	101.83	-42.17 to -52.17	Monitor the core of the RDX and perchlorate plumes.	A	Explosives, Perchlorate
MW-143M2	4,616,834	373,395	101.83	-15.17 to -20.17	Monitor the core of the RDX and perchlorate plumes.	A	Explosives, Perchlorate
MW-143M3	4,616,834	373,395	101.83	-5.17 to -10.17	Monitor the core of the RDX and perchlorate plumes.	A	Explosives, Perchlorate
MW-144M2	4,616,943	373,451	93.07	-36.93 to -46.93	Monitor the lower boundary of RDX and perchlorate plumes.	A	Explosives, Perchlorate
MW-155M1	4,616,559	373,176	96.01	-27.99 to -37.99	Monitor groundwater above the upper boundary of the perchlorate plume.	A	Explosives, Perchlorate

Table 5-1
J-3 Range 2011 Groundwater Chemical Monitoring Network

Location	Northing Coordinate (N83UTM m)	Easting Coordinate (N83UTM m)	Surface Elevation (ft msl)	Screen Interval (ft msl)	Rationale for Location	Frequency (a)	Parameters (b)
MW-157M1	4,616,582	373,433	81.33	-72.67 to -82.67	Monitor the lower boundary of the RDX plume and low level perchlorate detections from historic monitoring.	A	Explosives, Perchlorate
MW-157M2	4,616,582	373,433	81.33	-28.67 to -38.67	Monitor the core of the RDX plume and the lower boundary of the perchlorate plume.	A	Explosives, Perchlorate
MW-157M3	4,616,578	373,431	81.80	11.8 to 1.8	Monitor the upper boundary of the RDX and perchlorate plumes.	A	Explosives, Perchlorate
MW-163S	4,617,310	373,381	109.15	71.15 to 61.15	Monitor the source of the RDX and perchlorate plumes.	A	Explosives, Perchlorate
MW-171M2	4,615,904	373,520	68.98	-12.02 to -17.02	Monitor the leading edge of the RDX plume and groundwater downgradient of the perchlorate plume.	A	Explosives, Perchlorate
MW-193M1	4,617,213	373,439	100.71	43.21 to 38.21	Monitor the eastern edge of the RDX and perchlorate plumes.	A	Explosives, Perchlorate
MW-193S	4,617,214	373,439	100.71	68.21 to 63.21	Monitor the source of the RDX and perchlorate plumes.	A	Explosives, Perchlorate
MW-197M2	4,617,046	373,408	88.12	7.92 to 2.92	Monitor the core of the RDX and perchlorate plumes.	A	Explosives, Perchlorate
MW-197M3	4,617,047	373,408	88.12	27.92 to 22.92	Monitor the core of the RDX and perchlorate plumes.	A	Explosives, Perchlorate
MW-198M1	4,617,054	373,354	89.57	-60.43 to -65.43	Monitor groundwater at the lower boundaries of the RDX and perchlorate plumes.	A	Explosives, Perchlorate
MW-198M2	4,617,054	373,357	89.57	-30.43 to -35.43	Monitor groundwater in the core of the RDX and perchlorate plumes.	A	Explosives, Perchlorate
MW-198M3	4,617,054	373,357	89.57	-10.43 to -15.43	Monitor groundwater in the core of the RDX and perchlorate plumes	A	Explosives, Perchlorate
MW-198M4	4,617,054	373,357	89.57	19.57 to 14.57	Monitor groundwater in the core of the RDX and perchlorate plumes.	A	Explosives, Perchlorate
MW-217M2	4,616,185	373,433	69.71	-68.29 to -73.29	Monitor the leading edge of the RDX and perchlorate plumes.	A	Explosives, Perchlorate
MW-217M3	4,616,185	373,433	69.71	-31.29 to -36.29	Monitor the upper boundary of the RDX and perchlorate plumes.	A	Explosives, Perchlorate
MW-218M3	4,616,189	373,570	70.24	-7.76 to -12.76	Monitor the core of the RDX plume.	A	Explosives

Table 5-1
J-3 Range 2011 Groundwater Chemical Monitoring Network

Location	Northing Coordinate (N83UTM m)	Easting Coordinate (N83UTM m)	Surface Elevation (ft msl)	Screen Interval (ft msl)	Rationale for Location	Frequency (a)	Parameters (b)
MW-227M1	4,616,609	373,307	119.29	-10.71 to -20.71	Monitor the core of the RDX and perchlorate plumes.	A	Explosives, Perchlorate
MW-227M2	4,616,609	373,307	119.29	9.29 to -0.71	Monitor the core of the RDX and perchlorate plumes.	A	Explosives, Perchlorate
MW-227M3	4,616,609	373,307	119.29	54.29 to 44.29	Monitor the core of the perchlorate plume and groundwater at the upper boundary of the RDX plume.	A	Explosives, Perchlorate
MW-232M1	4,617,213	373,318	108.73	31.23 to 26.23	Monitor groundwater at the eastern boundary of the RDX plume and the core of the perchlorate plume.	A	Explosives, Perchlorate
MW-232M2	4,617,213	373,319	108.73	47.73 to 42.73	Monitor groundwater at the upper boundary of the perchlorate plume.	A	Perchlorate
MW-243M1	4,617,126	373,246	134.35	19.85 to 9.85	Monitor the core of the perchlorate plume.	A	Perchlorate
MW-243M2	4,617,126	373,246	134.35	49.85 to 39.85	Monitor groundwater at the core of the perchlorate plume.	A	Perchlorate
MW-247M1	4,616,383	373,299	87.76	-92.24 to -102.24	Monitor groundwater at the lower boundary of the RDX plume and the core of the perchlorate plume.	A	Explosives, Perchlorate
MW-247M2	4,616,383	373,299	87.76	-37.24 to -47.24	Monitor the core of the RDX and perchlorate plumes.	A	Explosives, Perchlorate
MW-247M3	4,616,383	373,299	87.76	-7.24 to -17.24	Monitor groundwater at the upper boundary of the RDX and perchlorate plumes.	A	Explosives, Perchlorate
MW-250M1	4,616,471	373,367	94.59	-90.41 to -100.41	Monitor groundwater at the lower boundary of the RDX plume and the core of the perchlorate plume.	A	Explosives, Perchlorate
MW-250M2	4,616,470	373,367	94.59	-50.41 to -60.41	Monitor groundwater at the core of the RDX and perchlorate plumes.	A	Explosives, Perchlorate
MW-250M3	4,616,470	373,367	94.59	-0.41 to -10.41	Monitor groundwater at the core of the RDX and perchlorate plumes.	A	Explosives, Perchlorate
MW-251M1	4,615,961	373,450	68.83	-59.17 to -64.17	Monitor groundwater at the leading edge of the RDX and perchlorate plumes.	A	Explosives, Perchlorate
MW-295M1	4,617,064	373,178	164.36	19.36 to 9.36	Monitor the western edge of the perchlorate plume.	A	Perchlorate
MW-295M2	4,617,063	373,178	164.36	47.36 to 37.36	Monitor the western edge of the perchlorate plume.	A	Perchlorate

Table 5-1
J-3 Range 2011 Groundwater Chemical Monitoring Network

Location	Northing Coordinate (N83UTM m)	Easting Coordinate (N83UTM m)	Surface Elevation (ft msl)	Screen Interval (ft msl)	Rationale for Location	Frequency (a)	Parameters (b)
MW-329M1	4,616,255	373,246	92.06	-87.9 to -97.9	Monitor core of perchlorate plume.	A	Perchlorate
MW-329M2	4,616,255	373,246	92.06	-57.99 to -67.99	Monitor core of perchlorate plume.	A	Perchlorate
MW-343M1	4,616,786	373,300	161.11	-53.72 to -63.72	Monitor groundwater at the lower boundary of the RDX plume and the core of the perchlorate plume.	A	Explosives, Perchlorate
MW-343M2	4,616,786	373,300	161.11	-5.71 to -10.71	Monitor the cores of the RDX and perchlorate plumes.	A	Explosives, Perchlorate
MW-359M2	4,616,924	373,077	162.85	14.23 to 4.23	Monitor potential perchlorate source area.	A	Perchlorate
SP3-91M	4,615,548	373,180	82.22	29.92 to 10.92	Monitor groundwater downgradient of RDX and perchlorate plumes.	B	Explosives, Perchlorate

Notes:
ft = feet
J-3 = J-3 Range
m = meters
msl = mean sea level
RDX = hexahydro-1,3,5-trinitro-1,3,5-triazine
NA = not applicable

(a)
A = annually
S = semiannually
B = biennial

(b)
Explosives = EPA Method SW846/8330
Perchlorate = EPA Method SW6860

Table 5-2
J-3 Range 2011 Groundwater Monitoring Results

Location	Sample Type	Analyte	Short Name	Test Method	Reported Result (ug/L)	Qualifier	Reporting Limit (ug/L)	Top of Screen (msl)	Bottom of Screen (msl)	Log Date
90EW0001	N1	Perchlorate	PCATE	SW6860	0.62		0.05	4.73	-55.97	09/19/2011
90EW0001	N1	Octahydro-1,3,5,7-	HMX	SW8330	2.1		0.2	4.73	-55.97	09/19/2011
90EW0001	N1	ND for 18 Analytes	Explosives	SW8330	ND	U	ND	4.73	-55.97	09/19/2011
90EW0001	N1	ND for 18 Analytes	Explosives	SW8330	ND	UJ	ND	4.73	-55.97	09/19/2011
90EW0001	N1	Perchlorate	PCATE	SW6860	0.64		0.05	4.73	-55.97	03/14/2011
90EW0001	N1	Hexahydro-1,3,5-Trinitro-	RDX	SW8330	0.17	J	0.2	4.73	-55.97	03/14/2011
90EW0001	N1	Octahydro-1,3,5,7-	HMX	SW8330	2.4	J	0.2	4.73	-55.97	03/14/2011
90EW0001	N1	ND for 17 Analytes	Explosives	SW8330	ND	U	ND	4.73	-55.97	03/14/2011
90EW0001	N1	ND for 17 Analytes	Explosives	SW8330	ND	UJ	ND	4.73	-55.97	03/14/2011
90MP0059B	N1	ND for 19 Analytes	Explosives	SW8330	ND	U	ND	-116.4	-118.9	09/22/2011
90MP0059B	N1	ND for 19 Analytes	Explosives	SW8330	ND	UJ	ND	-116.4	-118.9	09/22/2011
90PZ0204	N1	Perchlorate	PCATE	SW6860	0.12		0.05	-5.68	-10.68	09/21/2011
90PZ0204	N1	ND for 19 Analytes	Explosives	SW8330	ND	U	ND	-5.68	-10.68	09/21/2011
90PZ0204	N1	ND for 19 Analytes	Explosives	SW8330	ND	UJ	ND	-5.68	-10.68	09/21/2011
90PZ0211	N1	Perchlorate	PCATE	SW6860	0.081		0.05	-8.9	-35.9	09/21/2011
90PZ0211	N1	ND for 19 Analytes	Explosives	SW8330	ND	U	ND	-8.9	-35.9	09/21/2011
90PZ0211	N1	ND for 19 Analytes	Explosives	SW8330	ND	UJ	ND	-8.9	-35.9	09/21/2011
J3EW0032	N1	Perchlorate	PCATE	SW6860	0.82		0.05	-21.5	-71.5	09/19/2011
J3EW0032	N1	Hexahydro-1,3,5-Trinitro-	RDX	SW8330	0.85		0.2	-21.5	-71.5	09/19/2011
J3EW0032	N1	ND for 18 Analytes	Explosives	SW8330	ND	U	ND	-21.5	-71.5	09/19/2011
J3EW0032	N1	ND for 18 Analytes	Explosives	SW8330	ND	UJ	ND	-21.5	-71.5	09/19/2011
J3EW0032	N1	Perchlorate	PCATE	SW6860	0.84		0.05	-21.5	-71.5	03/14/2011
J3EW0032	N1	Hexahydro-1,3,5-Trinitro-	RDX	SW8330	0.63		0.2	-21.5	-71.5	03/14/2011
J3EW0032	N1	ND for 18 Analytes	Explosives	SW8330	ND	U	ND	-21.5	-71.5	03/14/2011
J3EW0032	N1	ND for 18 Analytes	Explosives	SW8330	ND	UJ	ND	-21.5	-71.5	03/14/2011
J3EWIP1	N1	Perchlorate	PCATE	SW6860	8.9		0.05	2.79	-37.21	09/16/2011
J3EWIP1	N1	Hexahydro-1,3,5-Trinitro-	RDX	SW8330	0.65		0.2	2.79	-37.21	09/16/2011
J3EWIP1	N1	Octahydro-1,3,5,7-	HMX	SW8330	0.27		0.2	2.79	-37.21	09/16/2011
J3EWIP1	N1	ND for 17 Analytes	Explosives	SW8330	ND	U	ND	2.79	-37.21	09/16/2011
J3EWIP1	N1	ND for 17 Analytes	Explosives	SW8330	ND	UJ	ND	2.79	-37.21	09/16/2011
J3EWIP1	FD1	Perchlorate	PCATE	SW6860	9.1		0.05	2.79	-37.21	09/16/2011
J3EWIP1	N1	Perchlorate	PCATE	SW6860	8		0.05	2.79	-37.21	03/14/2011
J3EWIP1	N1	Hexahydro-1,3,5-Trinitro-	RDX	SW8330	0.47	J	0.2	2.79	-37.21	03/14/2011
J3EWIP1	N1	ND for 18 Analytes	Explosives	SW8330	ND	UJ	ND	2.79	-37.21	03/14/2011
J3-MW-1-B	N1	Perchlorate	PCATE	SW6860	1		0.05	-15.43	-25.43	09/28/2011
J3-MW-1-B	N1	ND for 19 Analytes	Explosives	SW8330	ND	U	ND	-15.43	-25.43	09/28/2011
J3-MW-1-B	N1	ND for 19 Analytes	Explosives	SW8330	ND	UJ	ND	-15.43	-25.43	09/28/2011
J3-MW-1-C	N1	ND for 1 Analytes	Perchlorate	SW6860	ND	U	ND	-43.41	-53.41	09/28/2011
J3-MW-1-C	N1	ND for 19 Analytes	Explosives	SW8330	ND	UJ	ND	-43.41	-53.41	09/28/2011
MW-142M2	N1	Perchlorate	PCATE	SW6860	6.3		0.05	-28.14	-38.14	09/28/2011
MW-142M2	N1	Octahydro-1,3,5,7-	HMX	SW8330	1.1		0.22	-28.14	-38.14	09/28/2011
MW-142M2	N1	ND for 18 Analytes	Explosives	SW8330	ND	U	ND	-28.14	-38.14	09/28/2011
MW-142M2	N1	ND for 18 Analytes	Explosives	SW8330	ND	UJ	ND	-28.14	-38.14	09/28/2011

Table 5-2
J-3 Range 2011 Groundwater Monitoring Results

Location	Sample Type	Analyte	Short Name	Test Method	Reported Result (ug/L)	Qualifier	Reporting Limit (ug/L)	Top of Screen (msl)	Bottom of Screen (msl)	Log Date
MW-143M1	N1	Perchlorate	PCATE	SW6860	0.35		0.05	-42.63	-52.63	10/05/2011
MW-143M1	N1	ND for 19 Analytes	Explosives	SW8330	ND	U	ND	-42.63	-52.63	10/05/2011
MW-143M1	N1	ND for 19 Analytes	Explosives	SW8330	ND	UJ	ND	-42.63	-52.63	10/05/2011
MW-143M2	N1	Perchlorate	PCATE	SW6860	1.5		0.05	-15.63	-20.63	10/05/2011
MW-143M2	N1	Octahydro-1,3,5,7-	HMX	SW8330	3.1		0.25	-15.63	-20.63	10/05/2011
MW-143M2	N1	ND for 18 Analytes	Explosives	SW8330	ND	U	ND	-15.63	-20.63	10/05/2011
MW-143M2	N1	ND for 18 Analytes	Explosives	SW8330	ND	UJ	ND	-15.63	-20.63	10/05/2011
MW-143M2	FD1	Perchlorate	PCATE	SW6860	1.4		0.05	-15.63	-20.63	10/05/2011
MW-143M3	N1	Perchlorate	PCATE	SW6860	0.81		0.05	-5.62	-10.62	10/05/2011
MW-143M3	N1	Octahydro-1,3,5,7-	HMX	SW8330	1.6		0.24	-5.62	-10.62	10/05/2011
MW-143M3	N1	ND for 18 Analytes	Explosives	SW8330	ND	U	ND	-5.62	-10.62	10/05/2011
MW-143M3	N1	ND for 18 Analytes	Explosives	SW8330	ND	UJ	ND	-5.62	-10.62	10/05/2011
MW-143M3	FD1	Octahydro-1,3,5,7-	HMX	SW8330	1.7		0.22	-5.62	-10.62	10/05/2011
MW-143M3	FD1	ND for 18 Analytes	Explosives	SW8330	ND	U	ND	-5.62	-10.62	10/05/2011
MW-143M3	FD1	ND for 18 Analytes	Explosives	SW8330	ND	UJ	ND	-5.62	-10.62	10/05/2011
MW-144M2	N1	ND for 1 Analytes	Perchlorate	SW6860	ND	U	ND	-37.21	-47.21	09/28/2011
MW-144M2	N1	ND for 19 Analytes	Explosives	SW8330	ND	UJ	ND	-37.21	-47.21	09/28/2011
MW-155M1	N1	Perchlorate	PCATE	SW6860	0.13		0.05	-28.49	-38.49	09/28/2011
MW-155M1	N1	ND for 19 Analytes	Explosives	SW8330	ND	U	ND	-28.49	-38.49	09/28/2011
MW-155M1	N1	ND for 19 Analytes	Explosives	SW8330	ND	UJ	ND	-28.49	-38.49	09/28/2011
MW-157M1	N1	Perchlorate	PCATE	SW6860	0.65		0.05	-73.07	-83.07	09/27/2011
MW-157M1	N1	ND for 19 Analytes	Explosives	SW8330	ND	U	ND	-73.07	-83.07	09/27/2011
MW-157M1	N1	ND for 19 Analytes	Explosives	SW8330	ND	UJ	ND	-73.07	-83.07	09/27/2011
MW-157M2	N1	Perchlorate	PCATE	SW6860	0.2		0.05	-29.05	-39.05	09/27/2011
MW-157M2	N1	ND for 19 Analytes	Explosives	SW8330	ND	UJ	ND	-29.05	-39.05	09/27/2011
MW-157M3	N1	Perchlorate	PCATE	SW6860	0.13		0.05	11.82	1.82	09/27/2011
MW-157M3	N1	Octahydro-1,3,5,7-	HMX	SW8330	1.3		0.21	11.82	1.82	09/27/2011
MW-157M3	N1	ND for 18 Analytes	Explosives	SW8330	ND	U	ND	11.82	1.82	09/27/2011
MW-157M3	N1	ND for 18 Analytes	Explosives	SW8330	ND	UJ	ND	11.82	1.82	09/27/2011
MW-163S	N1	Perchlorate	PCATE	SW6860	1.6		0.05	70.75	60.75	10/06/2011
MW-163S	N1	Hexahydro-1,3,5-Trinitro-	RDX	SW8330	1.5		0.2	70.75	60.75	10/06/2011
MW-163S	N1	Octahydro-1,3,5,7-	HMX	SW8330	0.55		0.2	70.75	60.75	10/06/2011
MW-163S	N1	ND for 17 Analytes	Explosives	SW8330	ND	U	ND	70.75	60.75	10/06/2011
MW-163S	N1	ND for 17 Analytes	Explosives	SW8330	ND	UJ	ND	70.75	60.75	10/06/2011
MW-193M1	N1	Perchlorate	PCATE	SW6860	0.18		0.05	42.73	37.73	10/05/2011
MW-193M1	N1	Octahydro-1,3,5,7-	HMX	SW8330	0.54	J	0.22	42.73	37.73	10/05/2011
MW-193M1	N1	ND for 18 Analytes	Explosives	SW8330	ND	U	ND	42.73	37.73	10/05/2011
MW-193M1	N1	ND for 18 Analytes	Explosives	SW8330	ND	UJ	ND	42.73	37.73	10/05/2011
MW-193M1	FD1	Octahydro-1,3,5,7-	HMX	SW8330	0.75	J	0.23	42.73	37.73	10/05/2011
MW-193M1	FD1	ND for 18 Analytes	Explosives	SW8330	ND	U	ND	42.73	37.73	10/05/2011
MW-193M1	FD1	ND for 18 Analytes	Explosives	SW8330	ND	UJ	ND	42.73	37.73	10/05/2011
MW-193S	N1	Perchlorate	PCATE	SW6860	0.066		0.05	67.61	62.61	09/21/2011

Table 5-2
J-3 Range 2011 Groundwater Monitoring Results

Location	Sample Type	Analyte	Short Name	Test Method	Reported Result (ug/L)	Qualifier	Reporting Limit (ug/L)	Top of Screen (msl)	Bottom of Screen (msl)	Log Date
MW-193S	N1	ND for 19 Analytes	Explosives	SW8330	ND	U	ND	67.61	62.61	09/21/2011
MW-193S	N1	ND for 19 Analytes	Explosives	SW8330	ND	UJ	ND	67.61	62.61	09/21/2011
MW-193S	LR1	Perchlorate	PCATE	SW6860	0.069		0.05	67.61	62.61	09/21/2011
MW-197M2	N1	Perchlorate	PCATE	SW6860	0.39		0.05	7.4	2.4	09/22/2011
MW-197M2	N1	Octahydro-1,3,5,7-	HMX	SW8330	0.89		0.2	7.4	2.4	09/22/2011
MW-197M2	N1	ND for 18 Analytes	Explosives	SW8330	ND	U	ND	7.4	2.4	09/22/2011
MW-197M2	N1	ND for 18 Analytes	Explosives	SW8330	ND	UJ	ND	7.4	2.4	09/22/2011
MW-197M3	N1	Perchlorate	PCATE	SW6860	0.11		0.05	27.57	22.57	09/22/2011
MW-197M3	N1	Hexahydro-1,3,5-Trinitro-	RDX	SW8330	0.27	J	0.2	27.57	22.57	09/22/2011
MW-197M3	N1	Octahydro-1,3,5,7-	HMX	SW8330	3.2		0.2	27.57	22.57	09/22/2011
MW-197M3	N1	4-Amino-2,6-	A4DNT26	SW8330	0.19	J	0.2	27.57	22.57	09/22/2011
MW-197M3	N1	ND for 16 Analytes	Explosives	SW8330	ND	U	ND	27.57	22.57	09/22/2011
MW-197M3	N1	ND for 16 Analytes	Explosives	SW8330	ND	UJ	ND	27.57	22.57	09/22/2011
MW-197M3	FD1	Hexahydro-1,3,5-Trinitro-	RDX	SW8330	0.26	J	0.2	27.57	22.57	09/22/2011
MW-197M3	FD1	Octahydro-1,3,5,7-	HMX	SW8330	2.8	J	0.2	27.57	22.57	09/22/2011
MW-197M3	FD1	4-Amino-2,6-	A4DNT26	SW8330	0.16	J	0.2	27.57	22.57	09/22/2011
MW-197M3	FD1	ND for 16 Analytes	Explosives	SW8330	ND	UJ	ND	27.57	22.57	09/22/2011
MW-198M1	N1	Perchlorate	PCATE	SW6860	0.013	J	0.05	-60.88	-65.88	09/22/2011
MW-198M1	N1	ND for 19 Analytes	Explosives	SW8330	ND	U	ND	-60.88	-65.88	09/22/2011
MW-198M1	N1	ND for 19 Analytes	Explosives	SW8330	ND	UJ	ND	-60.88	-65.88	09/22/2011
MW-198M2	N1	Perchlorate	PCATE	SW6860	2.5		0.05	-31.49	-36.49	09/22/2011
MW-198M2	N1	ND for 19 Analytes	Explosives	SW8330	ND	U	ND	-31.49	-36.49	09/22/2011
MW-198M2	N1	ND for 19 Analytes	Explosives	SW8330	ND	UJ	ND	-31.49	-36.49	09/22/2011
MW-198M2	FD1	Perchlorate	PCATE	SW6860	2.5		0.05	-31.49	-36.49	09/22/2011
MW-198M3	N1	Perchlorate	PCATE	SW6860	2.4		0.05	-11.56	-16.56	09/22/2011
MW-198M3	N1	ND for 19 Analytes	Explosives	SW8330	ND	U	ND	-11.56	-16.56	09/22/2011
MW-198M3	N1	ND for 19 Analytes	Explosives	SW8330	ND	UJ	ND	-11.56	-16.56	09/22/2011
MW-198M4	N1	Perchlorate	PCATE	SW6860	8.4		0.25	18.52	13.52	09/22/2011
MW-198M4	N1	Hexahydro-1,3,5-Trinitro-	RDX	SW8330	1.3		0.2	18.52	13.52	09/22/2011
MW-198M4	N1	Octahydro-1,3,5,7-	HMX	SW8330	0.46		0.2	18.52	13.52	09/22/2011
MW-198M4	N1	ND for 17 Analytes	Explosives	SW8330	ND	U	ND	18.52	13.52	09/22/2011
MW-198M4	N1	ND for 17 Analytes	Explosives	SW8330	ND	UJ	ND	18.52	13.52	09/22/2011
MW-198M4	FD1	Perchlorate	PCATE	SW6860	8.4		0.25	18.52	13.52	09/22/2011
MW-227M1	N1	Perchlorate	PCATE	SW6860	0.076		0.05	-11.09	-21.09	09/29/2011
MW-227M1	N1	ND for 19 Analytes	Explosives	SW8330	ND	U	ND	-11.09	-21.09	09/29/2011
MW-227M1	N1	ND for 19 Analytes	Explosives	SW8330	ND	UJ	ND	-11.09	-21.09	09/29/2011
MW-227M2	N1	Perchlorate	PCATE	SW6860	2.1		0.05	8.88	-1.12	09/29/2011
MW-227M2	N1	Octahydro-1,3,5,7-	HMX	SW8330	1.7		0.22	8.88	-1.12	09/29/2011
MW-227M2	N1	Hexahydro-1,3,5-Trinitro-	RDX	SW8330	5.2	J	0.22	8.88	-1.12	09/29/2011
MW-227M2	N1	ND for 17 Analytes	Explosives	SW8330	ND	U	ND	8.88	-1.12	09/29/2011
MW-227M2	N1	ND for 17 Analytes	Explosives	SW8330	ND	UJ	ND	8.88	-1.12	09/29/2011
MW-227M2	FD1	Octahydro-1,3,5,7-	HMX	SW8330	1.9		0.23	8.88	-1.12	09/29/2011
MW-227M2	FD1	Hexahydro-1,3,5-Trinitro-	RDX	SW8330	5.5	J	0.23	8.88	-1.12	09/29/2011

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Table 5-2
J-3 Range 2011 Groundwater Monitoring Results

Location	Sample Type	Analyte	Short Name	Test Method	Reported Result (ug/L)	Qualifier	Reporting Limit (ug/L)	Top of Screen (msl)	Bottom of Screen (msl)	Log Date
MW-227M2	FD1	ND for 17 Analytes	Explosives	SW8330	ND	U	ND	8.88	-1.12	09/29/2011
MW-227M2	FD1	ND for 17 Analytes	Explosives	SW8330	ND	UJ	ND	8.88	-1.12	09/29/2011
MW-227M3	N1	Perchlorate	PCATE	SW6860	0.053		0.05	53.92	43.92	09/29/2011
MW-227M3	N1	ND for 19 Analytes	Explosives	SW8330	ND	U	ND	53.92	43.92	09/29/2011
MW-227M3	N1	ND for 19 Analytes	Explosives	SW8330	ND	UJ	ND	53.92	43.92	09/29/2011
MW-232M1	N1	Perchlorate	PCATE	SW6860	0.92		0.05	30.78	25.78	10/05/2011
MW-232M1	N1	ND for 19 Analytes	Explosives	SW8330	ND	U	ND	30.78	25.78	10/05/2011
MW-232M1	N1	ND for 19 Analytes	Explosives	SW8330	ND	UJ	ND	30.78	25.78	10/05/2011
MW-232M2	N1	Perchlorate	PCATE	SW6860	0.3		0.05	47.28	42.28	10/05/2011
MW-243M1	N1	Perchlorate	PCATE	SW6860	0.55		0.05	19.17	9.17	09/27/2011
MW-243M2	N1	Perchlorate	PCATE	SW6860	0.083		0.05	49.3	39.3	09/27/2011
MW-247M1	N1	Perchlorate	PCATE	SW6860	0.084		0.05	-92.76	-102.76	10/05/2011
MW-247M1	N1	ND for 19 Analytes	Explosives	SW8330	ND	U	ND	-92.76	-102.76	10/05/2011
MW-247M1	N1	ND for 19 Analytes	Explosives	SW8330	ND	UJ	ND	-92.76	-102.76	10/05/2011
MW-247M2	N1	Perchlorate	PCATE	SW6860	0.57		0.05	-37.77	-47.77	10/05/2011
MW-247M2	N1	ND for 19 Analytes	Explosives	SW8330	ND	U	ND	-37.77	-47.77	10/05/2011
MW-247M2	N1	ND for 19 Analytes	Explosives	SW8330	ND	UJ	ND	-37.77	-47.77	10/05/2011
MW-247M3	N1	Perchlorate	PCATE	SW6860	0.18		0.05	-7.8	-17.8	10/05/2011
MW-247M3	N1	ND for 19 Analytes	Explosives	SW8330	ND	U	ND	-7.8	-17.8	10/05/2011
MW-247M3	N1	ND for 19 Analytes	Explosives	SW8330	ND	UJ	ND	-7.8	-17.8	10/05/2011
MW-250M1	N1	Perchlorate	PCATE	SW6860	0.053		0.05	-109.8	-119.8	09/29/2011
MW-250M1	N1	ND for 19 Analytes	Explosives	SW8330	ND	UJ	ND	-109.8	-119.8	09/29/2011
MW-250M2	N1	Perchlorate	PCATE	SW6860	1.6		0.05	-69.78	-79.78	09/29/2011
MW-250M2	N1	ND for 18 Analytes	Explosives	SW8330	ND	U	ND	-69.78	-79.78	09/29/2011
MW-250M2	N1	ND for 18 Analytes	Explosives	SW8330	ND	UJ	ND	-69.78	-79.78	09/29/2011
MW-250M3	N1	Perchlorate	PCATE	SW6860	0.31		0.05	-19.8	-29.8	09/29/2011
MW-250M3	N1	ND for 19 Analytes	Explosives	SW8330	ND	U	ND	-19.8	-29.8	09/29/2011
MW-250M3	N1	ND for 19 Analytes	Explosives	SW8330	ND	UJ	ND	-19.8	-29.8	09/29/2011
MW-28	N1	ND for 47 Analytes	VOC	SW8260B	ND	U	ND	74.02	64.02	05/19/2011
MW-28	N1	ND for 47 Analytes	VOC	SW8260B	ND	UJ	ND	74.02	64.02	05/19/2011
MW-295M1	N1	Perchlorate	PCATE	SW6860	0.59		0.05	18.7	8.7	09/27/2011
MW-295M2	N1	Perchlorate	PCATE	SW6860	0.15		0.05	46.82	36.82	09/27/2011
MW-329M1	N1	Perchlorate	PCATE	SW6860	0.64		0.05	-88.45	-98.45	09/29/2011
MW-329M2	N1	Perchlorate	PCATE	SW6860	0.3		0.05	-58.64	-68.64	09/29/2011
MW-343M1	N1	Perchlorate	PCATE	SW6860	3.1		0.05	-54.39	-64.39	09/28/2011
MW-343M1	N1	ND for 19 Analytes	Explosives	SW8330	ND	U	ND	-54.39	-64.39	09/28/2011
MW-343M1	N1	ND for 19 Analytes	Explosives	SW8330	ND	UJ	ND	-54.39	-64.39	09/28/2011
MW-343M1	FD1	Perchlorate	PCATE	SW6860	3		0.05	-54.39	-64.39	09/28/2011
MW-343M2	N1	Perchlorate	PCATE	SW6860	0.56		0.05	-6.39	-11.39	09/28/2011

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Table 5-2
J-3 Range 2011 Groundwater Monitoring Results

Location	Sample Type	Analyte	Short Name	Test Method	Reported Result (ug/L)	Qualifier	Reporting Limit (ug/L)	Top of Screen (msl)	Bottom of Screen (msl)	Log Date
MW-343M2	N1	ND for 19 Analytes	Explosives	SW8330	ND	UJ	ND	-6.39	-11.39	09/28/2011
MW-359M2	N1	Perchlorate	PCATE	SW6860	0.088		0.05	13.83	3.83	09/27/2011
SP3-91M	N1	ND for 1 Analytes	Perchlorate	SW6860	ND	U	ND	-50	-70	09/20/2011
SP3-91M	N1	ND for 19 Analytes	Explosives	SW8330	ND	U	ND	-50	-70	09/20/2011
SP3-91M	N1	ND for 19 Analytes	Explosives	SW8330	ND	UJ	ND	-50	-70	09/20/2011

Notes:
ft msl - feet above mean sea level
ug/L - micrograms per liter
J - estimated concentration
U - not detected

N - primary field sample
FD - Field duplicate
NS - Not sampled

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Table 6-1:
J-3 Range Plume Measured and Predicted Perchlorate Concentrations

Name	Perchlorate (µg/L)		Deviation
	Measured	Predicted	(Predicted/Measured)
90EW0001	0.64	0.31	N/A
J3EW0032	0.84	0.37	N/A
J3EWIP1	9.10	11.00	**121%**
90PZ0204	0.12	0.06	N/A
90PZ0211	0.08	0.08	N/A
J3-MW-1-C	ND	0.32	N/A
MW-142M2	6.30	9.56	**152%**
MW-143M1	0.35	6.58	N/A
MW-143M3	0.81	12.28	N/A
MW-144M2	ND	0.28	N/A
MW-155M1	0.13	0.27	N/A
MW-157M1	0.65	0.02	N/A
MW-157M2	0.20	4.62	N/A
MW-157M3	0.13	0.75	N/A
MW-163S	1.60	0.07	N/A
MW-193M1	0.18	0.19	N/A
MW-193S	0.07	0.00	N/A
MW-197M2	0.39	5.84	N/A
MW-197M3	0.11	0.60	N/A
MW-198M1	0.01	0.00	N/A
MW-198M2	2.50	8.87	**355%**
MW-198M3	2.40	55.99	**2333%**
MW-198M4	8.40	9.88	**118%**
MW-227M1	0.08	1.57	N/A
MW-227M2	2.10	0.61	**29%**
MW-227M3	0.05	0.00	N/A
MW-232M1	0.92	13.56	N/A
MW-232M2	0.30	1.56	N/A
MW-243M1	0.55	0.77	N/A
MW-243M2	0.08	0.10	N/A
MW-247M1	0.08	0.00	N/A
MW-247M2	0.57	0.65	N/A
MW-247M3	0.18	1.43	N/A
MW-250M1	0.05	0.00	N/A
MW-250M2	1.60	1.91	N/A
MW-250M3	0.31	1.37	N/A
MW-295M1	0.59	0.51	N/A
MW-295M2	0.15	0.02	N/A
MW-329M1	0.64	0.00	N/A
MW-329M2	0.30	0.06	N/A
MW-343M1	3.10	1.76	**57%**
MW-343M2	0.56	10.51	N/A
MW-359M2	0.09	0.11	N/A
SP3-91M	ND	0.00	N/A

Notes:
ND - not detected
N/A - measured concentration less than 2 µg/L and comparison not made.
Red is under-predicted and green is over-predicted.

Table 6-2:
J-3 Range Plume Measured and Predicted RDX Concentrations

Name	RDX (µg/L)		Deviation
	Measured	Predicted	(Predicted/Measured)
90EW0001	0.17	0.14	N/A
J3EW0032	0.85	0.56	66%
J3EWIP1	0.65	0.33	51%
90PZ0204	ND	0.09	N/A
90PZ0211	ND	0.12	N/A
J3-MW-1-C	ND	0.15	N/A
MW-142M2	ND	0.06	N/A
MW-143M1	ND	0.03	N/A
MW-143M3	ND	0.09	N/A
MW-144M2	ND	0.00	N/A
MW-155M1	ND	0.00	N/A
MW-157M1	ND	0.01	N/A
MW-157M2	ND	0.06	N/A
MW-157M3	ND	0.41	N/A
MW-163S	1.50	0.01	1%
MW-193M1	ND	0.34	N/A
MW-193S	ND	0.00	N/A
MW-197M2	ND	0.43	N/A
MW-197M3	0.27	1.10	N/A
MW-198M1	ND	0.00	N/A
MW-198M2	ND	0.80	N/A
MW-198M3	ND	2.00	N/A
MW-198M4	1.30	0.89	68%
MW-227M1	ND	7.73	N/A
MW-227M2	5.20	3.09	59%
MW-227M3	ND	0.00	N/A
MW-232M1	ND	1.84	N/A
MW-247M1	ND	0.00	N/A
MW-247M2	ND	0.45	N/A
MW-247M3	ND	1.34	N/A
MW-250M1	ND	0.00	N/A
MW-250M2	ND	1.50	N/A
MW-250M3	ND	3.32	N/A
MW-343M1	ND	0.04	N/A
MW-343M2	ND	0.29	N/A
SP3-91M	ND	0.00	N/A

Notes:
ND - not detected
N/A - measured concentration less than 0.6 µg/L and comparison not made.
Red is under-predicted and green is over-predicted.

APPENDIX A

PROJECT NOTE

Client, Project and Location:
Impact Area Groundwater Study Program
National Guard Bureau
J-3 Range In-Plume Area Drive Points
Camp Edwards, MA

Subject: J-3 Range In-Plume & Downgradient Drive Point Investigation

Date: January 2012

PURPOSE

The purpose of this Project Note is to document regulatory agency concurrence with the proposed drive point investigation in the vicinity of the J-3 in-plume extraction well J3EWIP1. The investigation will provide aquifer profile data to help determine the thickness of the perchlorate plume in the area upgradient and in the vicinity of J3EWIP1. The data obtained during this investigation will be used to determine if the extraction well screen configuration and/or pumping rate can be optimized to capture the high concentrations of perchlorate in this portion of the plume in a more efficient manner. Additionally, the downgradient drive-points will be used to verify segmentation of the perchlorate plume downgradient of the stagnation point of the in-plume extraction well.

GROUNDWATER DATA/SYSTEM PERFORMANCE

Relatively high concentrations of perchlorate have been detected in groundwater samples collected from MW-198 well cluster since its installation in 2002. Perchlorate concentrations above 100 µg/L have been detected in samples from MW-198M3 from 2002 to 2008, peaking at 770 µg/L in 2005. Perchlorate concentrations above 100 µg/L have been detected in MW-198M2 from 2004 to 2008 and in MW-198M4 from 2002 to 2005, indicating that a significant mass of perchlorate is migrating through this area of the aquifer. The J-3 ETR system, which began operating in August 2006, incorporated an in-plume extraction well (J3EWIP1) that was specifically designed to capture these high concentrations of perchlorate. From start-up in November 2007, the J3EWIP1 well extracted groundwater at a rate of 60 gpm. This rate was then increased to 100 gpm in September 2009. As of October 2011 the J-3 RRA system has processed a total of 478.5 million gallons of contaminated water and removed 13 pounds of perchlorate. This compares to a model-predicted mass removal of 20 pounds through October 2011. As depicted in Figure 1, the model-predicted plume is slightly wider at the 2 µg/L and 15 µg/L contour and predicts a smaller high concentration zone of perchlorate above 200 µg/L.

Since a majority of the perchlorate mass resides in this upgradient portion of the plume it is important that capture be accomplished at J3EWIP1, as the operational time-frame for the J-3 ETR system would likely be extended if a significant amount of this mass were to elude capture at this location. The proposed work will help update the configuration of the high concentration portion of the perchlorate plume and assist in determining if optimization of the operating parameters of the in-plume extraction well is warranted.

Distribution: L. Jennings and J. Dolan (EPA); L. Pinaud and M. Panni (MassDEP); B. Gregson, D. Hill, P. Richardson, and M. Goulet (IAGWSP); D. Smith, D. Margolis, J. Ehret, K. Heim, and G. Kaso (USACE).

Additionally, the J-3 perchlorate plume shell may be updated after receipt of the drive point results if there is a significant enough difference from our current understanding of the plume.

PROPOSED EXTRACTION WELL PROFILING

In order to evaluate optimization of the screened interval and/or pumping rate at J3EWIP1 the extraction well screened interval will be profiled using temporary inflatable packers. To do this, the well will be shut down 120 hours prior to the start of the profiling in order to allow the aquifer and aquifer natural chemistry to stabilize to more ambient conditions. Once stabilization occurs the extraction well pump will be pulled and a set of inflatable packers will be lowered into the well. Beginning at the bottom, the well will be sealed at five foot intervals and a low flow sample will be taken for analysis of perchlorate. The sampling activity is expected to be completed and the extraction well returned to service within 9 days of the initial shut down.

PROPOSED DRIVE POINTS

To confirm the current position of the core of the perchlorate plume a series of drive points will be installed at locations between the MW-198 well cluster and the extraction well to determine if significant concentrations of perchlorate reside below, cross-gradient or downgradient of and beyond the interpreted capture zone of J3EWIP1 (Figure 2). Influent concentrations at the in-plume extraction well increased from 5.3 µg/L in September 2009 to 12 µg/L in October 2010, likely indicating that the perchlorate core is starting to reach the extraction well.

Three drive points will be installed along the axis of the perchlorate plume at distances of approximately 250 feet, 400 feet and 650 feet downgradient of MW-198 (DP-1 through DP-3) as depicted in Figure 1, in order to reacquire the high concentration perchlorate core. Two drive points will also be installed at locations cross-gradient from DP-2, approximately 150 feet to the west and 100 feet to the east of DP-2 (DP-4 and DP-5). DP-4 and DP-5 are intended to help determine the width of the perchlorate plume and were located based largely on accessibility considerations in the field. A sixth drive point (DP-6) will be advanced slightly east and south of MW-143, outside the simulated capture zone of J3EWIP1, to see if contamination above 2 µg/L exists outside the capture zone. Contamination under these circumstances would continue to migrate downgradient toward extraction wells J3EW0032 and 90EW0001, located approximately 1600 feet further downgradient.

Aquifer profile samples collected from DP-1 through DP-7 will be collected at 10-foot intervals, starting at a depth of approximately 10 feet below the water table, and continuing to refusal depth. All samples will be analyzed for perchlorate and explosives using SW-846 Methods 6850 and 8330, respectively. It is anticipated that after all profile samples are collected that the drive points will be removed with the exception of DP-6. At DP-6 a piezometer will be installed at -15 to -20 ft msl, which is the equivalent depth of the nearby MW-143M2 screen. The piezometer will be used solely to collect water levels.

Drive point DP-7 will be advanced approximately 300 feet downgradient of J3EWIP1, beyond the simulated stagnation point of the in-plume well (see Figure 1 inset). The purpose of this boring is to determine if any portion of the perchlorate plume is eluding capture and if the plume exhibits segmentation after several years of pumping. Additionally, this boring will be used to determine if contamination detected in MW-343M1 in October 2010 (4.2 µg/L) is under-flowing the extraction well. Based on the results of drivepoints DP-1 through DP-6, the location of DP-7 may be adjusted westward or southwestward to optimize the placement downgradient of the J3EWIP1.

Water levels will be checked the morning after the water table is encountered at each drive point location to determine the approximate depth to groundwater at each location.

All work will be conducted and all samples will be collected in accordance with established protocols. If the desired data are not obtainable using a drive point rig another drilling method will be considered. All drive-point locations will be surveyed for horizontal placement and vertical elevation (ground surface). Additionally, the top of PVC casing will be surveyed at DP-6 in order to determine the groundwater elevation.

CONCURRENCE

Concurrence with the recommendations presented in this project note is represented by the signatures below:

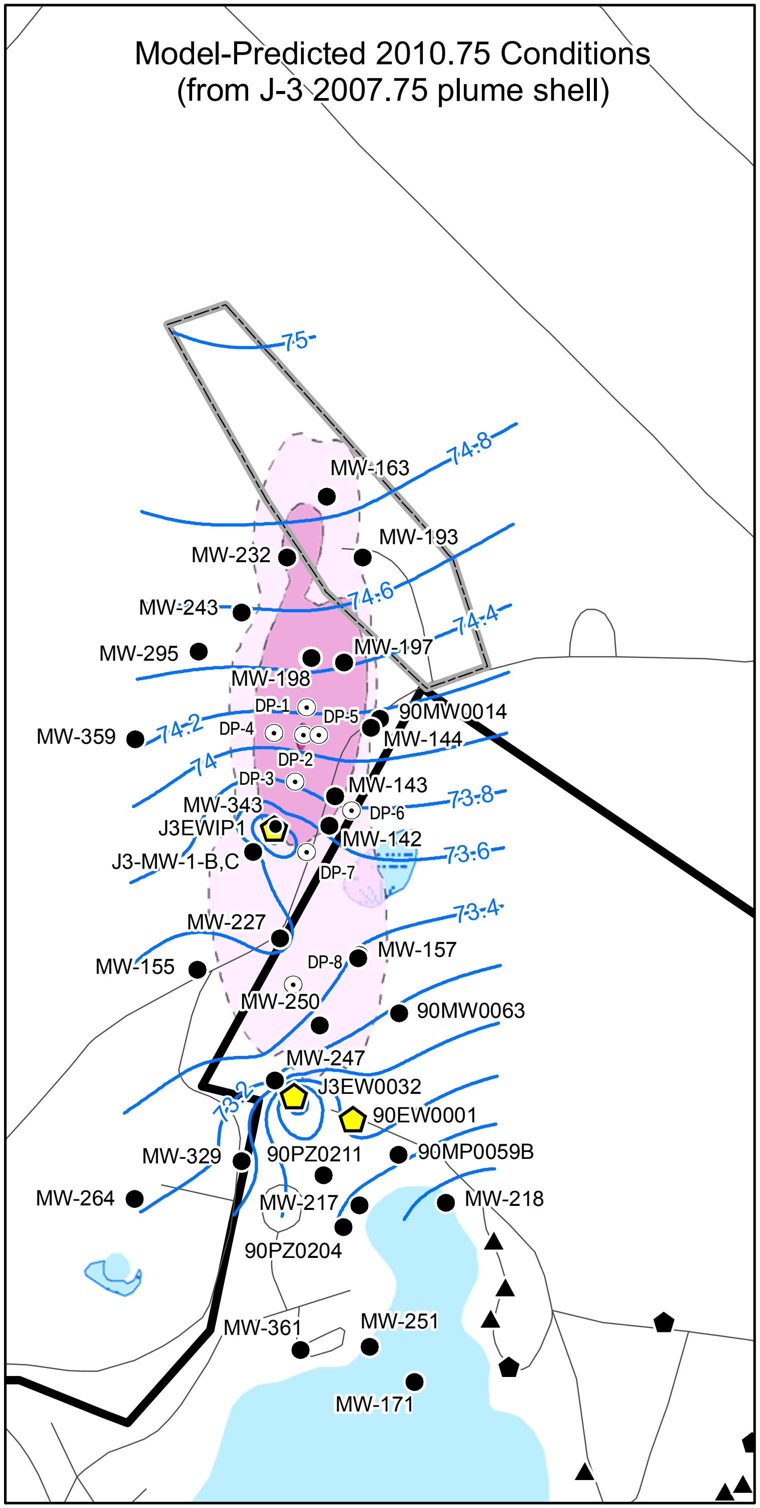
Jane Dolan 1/26/12
USEPA Representative

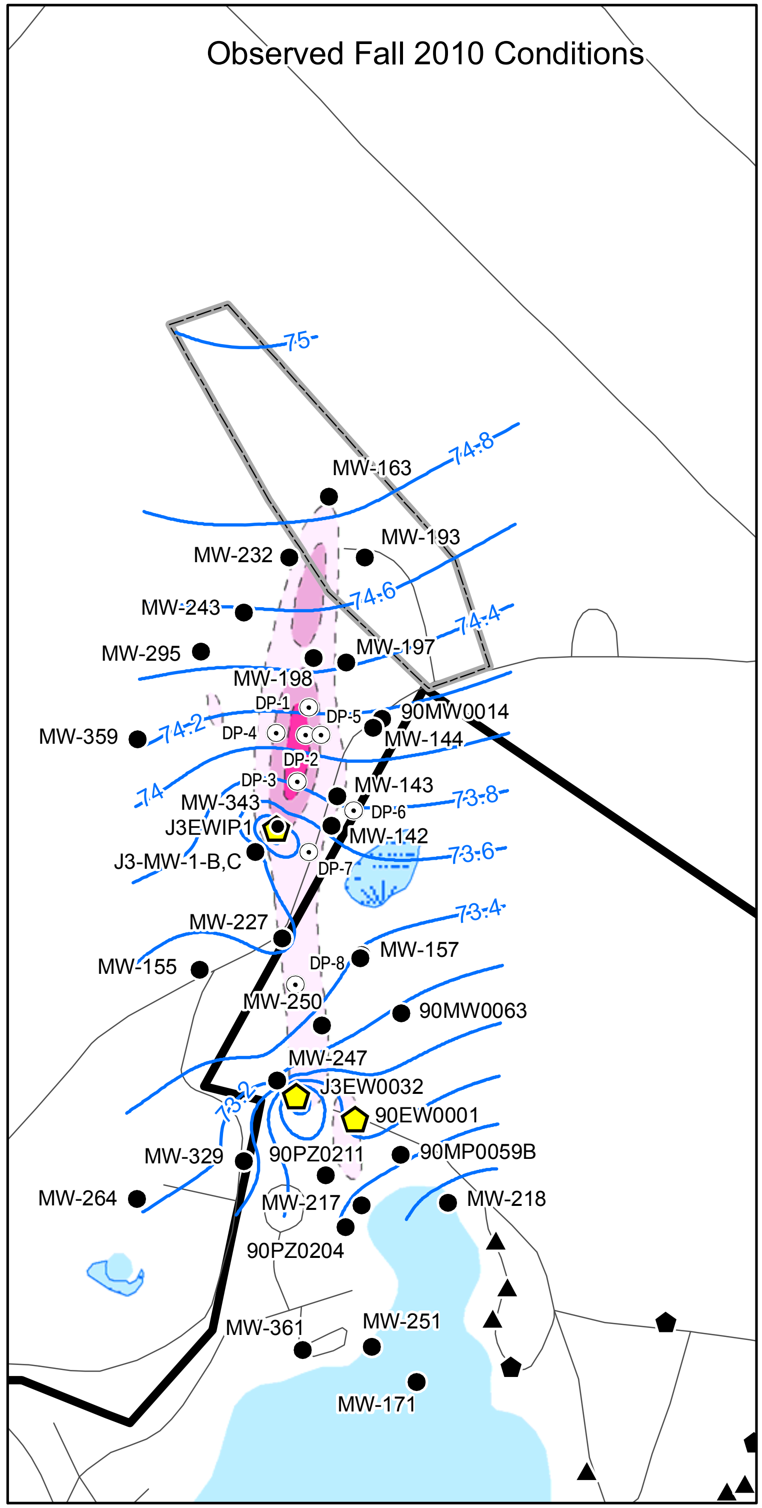
1/26/2012
MassDEP Representative

Benjamin P. Gregson 1.26.2012
IAGWSP Representative

Figure 1 J-3 Perchlorate Plume – Model Predicted and Observed Outline
Figure 2 J-3 In-Plume Area Proposed Drive Point Locations

FIGURES





Impact Area
Groundwater Study Program

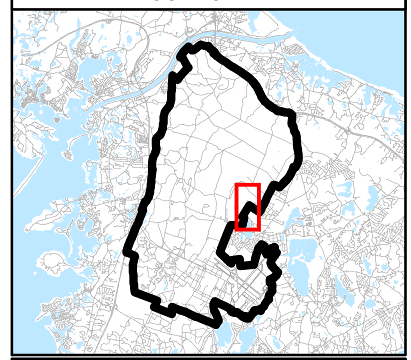
LEGEND

- Proposed Drive Point
- Monitoring Well
- J-3 Extraction Well (operational)
- FS-12 Extraction Well (operational)
- Reinjection Well (operational)
- J-3 Range Boundary
- MMR Boundary
- 73.4 Depicts 25 October 2010 Potentiometric Surface (feet mean sea level)

Perchlorate Detections

- 2-15 µg/L
- 15-200 µg/L
- Greater than 200 µg/L

LOCATION MAP



NOTES & SOURCES

Map Coordinate System: NAD83 UTM Zone 19N Meters
Basemap data from US Geological Survey 7 1/2 minute
Topographic Maps: Source: MassGIS

TITLE

J-3 Plume Perchlorate
Model-Predicted and Observed Outline

0 1,000 Feet

N

US Army Corps of Engineers
New England District

FIGURE 1

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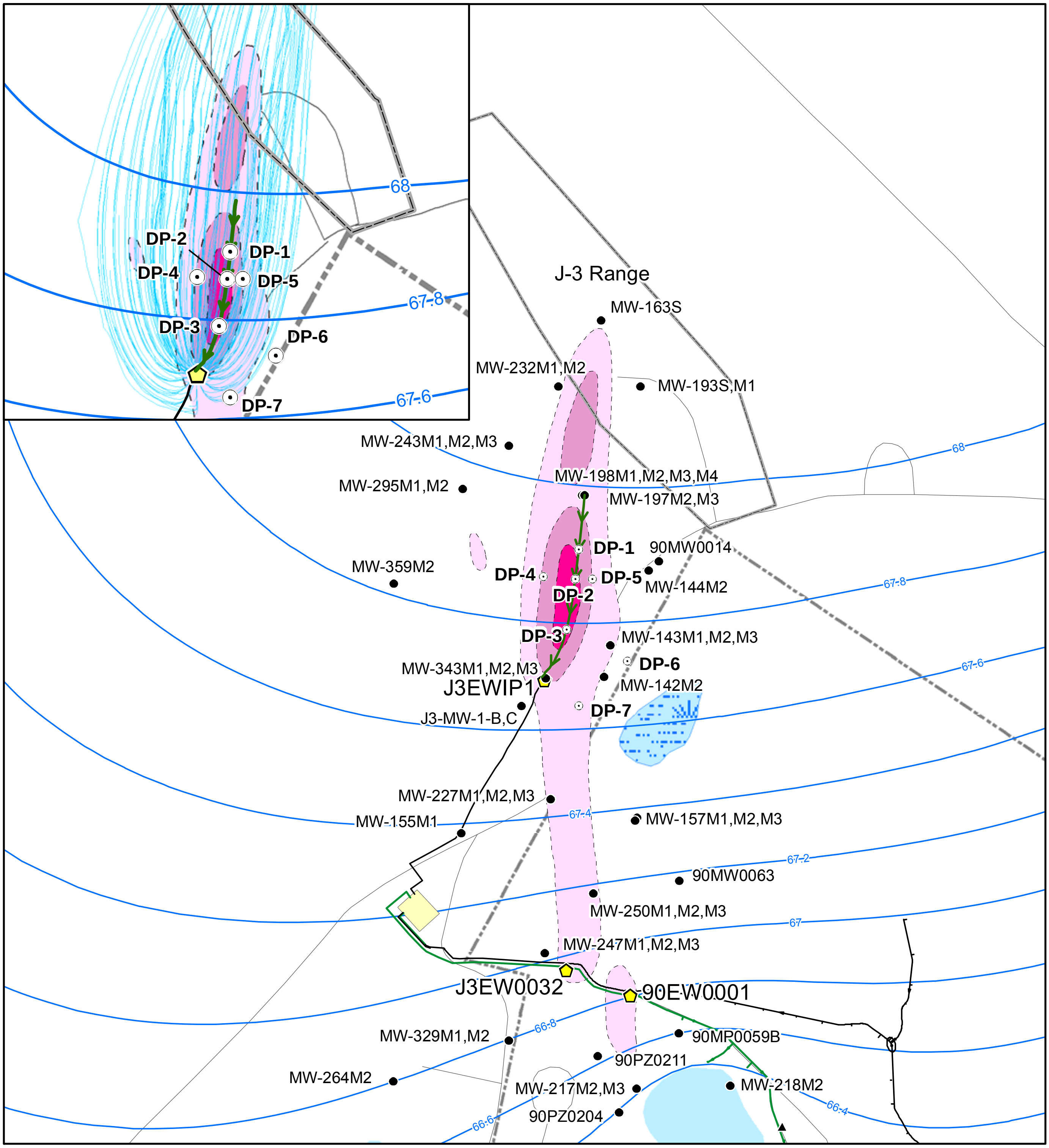
January 25, 2012 DWN: MTW CHKD: KJH



<u>Legend</u>

- Proposed Drive Point
- Monitoring Well
- J-3 Extraction Well (operational)
- Forward Particle Track with 1 year time markers
- 67.6 — 2003 Synoptic Water Table Contours (feet mean sea level)
- J3EW1P1 Capture Zone Particle Tracks

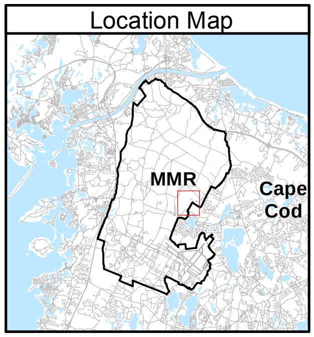
Perchlorate Detections

- 2-15 µg/L
- 15-200 µg/L
- Greater than 200 µg/L

- J-3 Range Boundary
- MMR Boundary

Plume: Fall 2010

Location Map



N

0 700 Feet

TITLE
J-3 Range In-Plume Area Proposed Drive Point Locations

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January 25, 2012 DWN: MTW CHKD: KJH

Impact Area
Groundwater Study Program

FIGURE
2

APPENDIX B

DEPARTMENT OF THE ARMY
NEW ENGLAND DISTRICT, CORPS OF ENGINEERS
696 VIRGINIA ROAD
CONCORD, MASSACHUSETTS 01742-2751

REPLY TO
ATTENTION OF

July 20, 2012

Engineering/Planning Division
Geo-Environmental Engineering Branch

Ms. Lynne Jennings
EPA – New England, Region 1
5 Post Office Square – Suite 100
Mail Code OSRR7-3
Boston, Massachusetts 02109-3912

Mr. Len Pinaud
Massachusetts Department of Environmental Protection
20 Riverside Drive
Lakeville, Massachusetts 02347

Re: Impact Area Groundwater Study Program
USEPA Region I Administrative Orders SDWA 1-97-1019 and 1-2000-0014
Memorandum of Resolution for the Draft J-3 Range Interim Environmental Monitoring Report, December 2010 through November 2011, dated April 2012

Dear Ms. Jennings and Mr. Pinaud:

On behalf of the National Guard's Impact Area Groundwater Study Program (IAGWSP), the U.S. Army Corps of Engineers (USACE) is pleased to provide the enclosed Memorandum of Resolution (MOR) for EPA comments on the Responses to Comments Letter (RCL), dated June 5, 2012, for the Draft J-3 Range Interim Environmental Monitoring Report, December 2010 through November 2011, dated April 2012. Comments were received from U.S. Environmental Protection Agency (EPA) in a letter dated May 17, 2012, and from the Massachusetts Environmental Protection Agency (MassDEP) in a letter dated May 14, 2011. EPA provided additional comments in a letter dated July 12, 2012. MassDEP approved the RCL in a letter dated June 12, 2012.

Your approval of the enclosed MOR is requested by July 27, 2012.

Please contact Dave Hill of the IAGWSP or Mark Anderson of USACE if there are any questions.

Sincerely,

H. Farrell McMillan, P.E.
Chief, Engineering/Planning Division

Enclosure

Copy Furnished:
Hard Copy:

EPA: Jane Dolan

Electronic:
IAGWSP: Ben Gregson, Dave Hill, Marcia Goulet
EPA: Erin Sanborn
USACE: Gina Kaso, Jay Ehret, Mark Anderson, Ken Heim, Marie Wojtas

Impact Area Groundwater Study Program
Memorandum of Resolution
For
Responses to US Environmental Protection Agency Protection Comments on the Draft J-3 Range Interim Environmental Monitoring Report December 2010 through November 2011
Dated: April 2012

EPA COMMENTS (LETTER DATED July 12, 2012) ON DRAFT J-3 RANGE INTERIM ENVIRONMENTAL MONITORING REPORT DECEMBER 2010 THROUGH NOVEMBER 2011.

GENERAL COMMENTS

2) The capture zones for the individual extraction wells in the J-3 area are presented in Figure 6-8. The monitoring report indicates that these capture zones were developed using particle tracking and the calibrated model for the J-3 area. The text further indicates that the model was calibrated based on the base scenario, which consisted of the regional model calibrated to the 2003 (non-system) conditions, but simulating the 2011 injection/extraction rates. However, the particle tracks presented in Figure 6-8 do not appear to reflect the flow anomalies recently observed downgradient of extraction well J3EWIP1 in the area of the MW-227 cluster and extending eastward towards the MW-157 cluster as well as northeastward toward the MW-142 well cluster (see Specific Comment No. 1). Thus, the capture zones depicted in Figure 6-8 do not appear to reflect current conditions at the site.

Response: MW-227 has been recommended for resurveying and was intentionally not included in determination of groundwater contours. If the resurvey indicates that the water surface elevation is correct then the anomalous water level will be addressed in the next annual report.

Additional EPA Comment: Please provide a date when MW-227 will be re-surveyed. Please also provide a date before the next annual report when a memo addressing the anomalous (if verified) water level will be provided. EPA suggests within X weeks of the re-survey.

Final Resolution: The recommendation in the annual report will be updated to indicate that the well should be resurveyed prior to November 2012, so that the information can be used during the evaluation of data for the next annual report.

SPECIFIC COMMENTS

2) Pg 4-1, §4.2 - The potentiometric surface and groundwater flow vectors for J-3 groundwater based on September 2011 water-level data is presented in Figure 4-2. When discussing the depicted potentiometric surface, the monitoring report indicates that “the water levels reported for the MW-227 well cluster were anomalously high suggesting a J3EWIP1 stagnation zone that is much farther downgradient than expected.” The MW-227 cluster is recommended for survey to verify the reported water-level measurements. The monitoring report (pg. 4-2) further indicates that the “downgradient stagnation point of the J3EWIP1 extraction well lies north of the MW-227 well cluster and that “groundwater downgradient of MW-227 wells continue to move southward and converges on either well J3EW0032 or 90EW0001.” However, inspection of the potentiometric surface depicted in Figure 4-2 indicate that the water levels observed in the MW-227 are indicative of a potential area of bypass west of and around the capture zone created by J3EWIP1. This area of likely bypass is in the immediate vicinity of and west of the J3-MW-1 cluster. Groundwater in this area appears to flow southeastward toward the MW-227 cluster. Furthermore, at the MW-227 cluster, a significant component of flow towards the east and southeast, rather than the south, is evident. Based on the potentiometric surface and flow vectors depicted on Figure 4-2, a significant component of flow may pass eastward past the MW-157 cluster. Groundwater flow passing to the east of the MW-157 cluster may pass beyond the apparent capture zone created by 90EW0001. While groundwater quality data does not currently appear to indicate that groundwater contamination is migrating past the MW-157 cluster, there are potential inadequacies in the current monitoring network that may not allow the detection of contaminant migration in this area (see Specific Comments Nos. 4 and 5). Moreover, additional

investigations are planned for the J-3 area which may result in the redefinition of the plume configuration. Consequently, the monitoring report should be revised to fully discuss the potential implication of groundwater levels measured in and around the MW-227 cluster.

Response: The water level measurement makes no obvious hydrologic sense so a recommendation has been made to resurvey the well before speculating on all the reasons for the elevated water level and potential implications. No changes or additions will be made to the report.

Additional EPA Comment: Please provide a date when MW-227 will be re-surveyed.

Final Resolution: The EMR is meant to report information and make recommendations and is not believed to be the appropriate place to set schedules, thereby no date is being added to the report. Furthermore, as indicated in the final resolution to General Comment 2, the re-survey of MW-227 will take place by November 2012 so that the information can be used during the evaluation of data for the next annual report.

4) Pg 4-2, §4.3 - Four wells for which groundwater levels are regularly monitored by the USGS have been referenced to provide an indication of regional trends in groundwater levels. Web addresses have been provided to obtain the hydrographs for each of these wells. Please include the relevant USGS water level data in an appendix to the monitoring report and in that appendix discuss in appropriate detail how the comparison was made between the regional water level changes and the site water level changes and the significance of any differences. Also, it would be helpful if a figure were provided which illustrates the location of each of the USGS wells. Please discuss and demonstrate the relevance of the regional hydrographs to the groundwater flow regime at the J-3 Range.

Response: The following text will be added: "The four USGS wells provide a detailed history of groundwater levels near the top of the regional groundwater mound. The USGS wells are superior to using J-2 Range monitoring wells because of their long data history and frequency of data collection (every 15 minutes) while the water levels at the J-3 Range wells are measured just a few times per year" Graphs will not be added to the appendix since detailed information is already available from the USGS website.

Additional EPA Comment: Replace "J-2 Range monitoring wells" with "J-3 Range monitoring wells".

Final Resolution: The number "2" will be replaced with "3".

6) Pg 5-2, §5.1.1, par 6 – Please clarify that perchlorate detected from well MW-143 is captured by extraction well J3EW1P1 under average water table conditions but may not be captured under high water table conditions. Please comment upon the predicted travel time from MW-198 to J3EW0001.

Response: The following sentence will be added to paragraph six of Section 5.1.1: "This was corroborated in the 2010 J3 EMR when numerical modeling indicated that under average water table conditions contamination at the MW-143 well cluster would be captured but under high water table conditions capture may not be fully achieved". There is no well "J3MW0001" in the J3 system.

Additional EPA Comment: The comment intended to inquire about the travel time from MW-198 to extraction well J3EW1P1. Please provide the predicted travel time from MW-198 to extraction well J3EW1P1.

Final Resolution: The sentence "The travel time from the monitoring wells in the MW-198 cluster to the J3EWIP1 extraction well is predicted to be approximately 100 years for MW-198M1, 12 years for MW-198M2, and 5 years for both MW-198M3 and MW-198M4. The relatively short travel time from the shallow monitoring wells is due to the relatively high hydraulic conductivity in sediments at an elevation greater than approximately -30 ft msl and the increased travel times from deeper monitoring wells MW-198M2 and especially MW-198M1 reflect the much lower hydraulic conductivity in sediments deeper than -30 ft msl" will be added to Section 5.1.1.

7) Pg 5-3, §5.1.1 - Please indicate whether MW-142 is within the capture zone of J3EW0001. Also, when discussing the perchlorate plume upgradient of the base boundary, the monitoring report indicates that the concentrations in wells located west of J3EWIP1 (J3-MW-1-B and J3-MW-1-C) were below 2.0 µg/l, indicating that the plume is adequately bounded in the western vicinity of the extraction well. However, it should be noted that J3-MW-1-B and J3-MW-1-C are screened between -14.8 ft msl and -24.8 ft msl and between 42.8 ft msl and -52.8 ft msl, respectively. Based on the perchlorate concentrations depicted at nearby MW-343 cluster in plume cross section D-D' presented in Figure 5-2, it appears that J3-MW-1-B may be screened above the core (highest concentrations) of the perchlorate plume and unable to detect the highest concentration in the plume passing north of J3EWIP1. Moreover, it appears that J3-MW-1-C may be screened largely within a sand and silt/clay. Thus, this well may not adequately monitor the higher permeability sands below the screen in this area which would likely provide the most likely contaminant migration pathway at this depth. Elevated perchlorate concentrations are already being observed in nearby MW-343-M1 in these sands. Evidence indicates that the core of the perchlorate plume is now advancing toward J3EWIP1. Moreover, the potentiometric contours presented in Figure 4-2 indicate that this is a potential area of bypass around J3EWIP1 (see Specific Comment No. 1). This potential deficiency in the current monitoring network should be acknowledged in the monitoring report. Depending on the outcome of the planned drive point investigation, the installation of additional monitoring wells in the J3-MW-1 cluster screened at more suitable depths should be considered. To ensure that any contamination migrating to the north of MW-343 is fully characterized, it is also recommended that the planned drive point investigation include an additional drive point in the area of J3-MW-1 cluster, with profiling over the entire overburden thickness.

Response: There is no well "J3EW0001" in the J3 system. There is no clear indication that J3-MW1 is screened at the wrong elevation. The mid-depth screen is above the core of the upgradient plume but the particle paths, the capture zone, and hydraulic gradients indicate that plume would move vertically upward as it approaches the J3EWIP1 extraction well. Also, concentrations at MW-343 are expected to increase given how close it is to the extraction well. The drive-point program currently being undertaken will shed more light on the elevation of the core of the perchlorate plume.

Additional EPA Comment: The comment intended to inquire if monitoring well MW-142 is within the capture zone of J3EW1P1. Please indicate whether MW-142 is within the capture zone of J3EW1P1. In addition, it is indicated that "there is no clear indication that J3-MW-1 is screened at the wrong elevation." However, the cross-section shown on Figure 5-2 depicts a clay/silt upgradient of J3-MW-1C as well as a sand and silt/clay horizon between the extraction well and the screen of J3-MW-1C. The water levels depicted on Figure 4-2 also indicate vertical hydraulic gradients at J3-MW-1 and MW-343 which may be indicative of hydraulic isolation (low permeability materials) between the deep and middle zones in this general area. However, as the comment indicated, the planned drive-point program should provide additional information with which to evaluate contaminant migration pathways and capture zones in this general area.

Final Resolution: The sentence "Previous groundwater modeling described in the 2010 EMR (IAGWSP, 2011) indicates that contamination at monitoring well MW-142M2 is likely captured [this determination will be aided by information gained in the recommended drive-point program]., will be added to Section 5.1.1 to summarize the extent of capture in relation to the MW-142 well cluster.

13) Pg 6-5, §6.2.1 - Please reconcile the discussion in the second full paragraph wherein the concentrations of RDX are presented with the discussion on page 6-3 in Section 6.1.2 where it is stated that the RDX concentrations at J3EWIP1 were 0.65 µg/L measured versus 0.361 µg/L modeled. The RDX concentrations in these two discussions are not consistent. Please correct.

Response: Section 6.1.2 is related to RDX and Section 6.2.1 is related to perchlorate so the comment is unclear.

Additional EPA Comment: The comment should have referenced the discussion on page 6-5 of Section 6.2.2 (not Section 6.2.1). The discussion indicated that the RDX concentration predicted by the model at extraction well J3EWIP1 was very similar to the measured concentration, and both are approximately 0.4 µg/l to 0.5 µg/l. However, Section 6.1.2 states that "at the in-plume extraction well (J3EWIP1), the model simulated influent concentrations (measured 0.65 ug/l versus modeled 0.361 ug/l) reliably." These two statements do not appear consistent and should be reconciled as appropriate.

Final Resolution: The statement in Section 6.2.1 "At the in-plume extraction well (J3EWIP1), the model simulated influent concentrations (measured 0.65 µg/L versus modeled 0.361) reliably" was changed to "At the in-plume extraction well (J3EWIP1), the model simulated influent concentrations (measured 0.65 µg/L versus modeled 0.46 µg/L in March 2011 and measured 0.47 µg/L versus modeled 0.37 µg/L in September 2011) reliably" to reconcile with the Section 6.2.2 on page 6-5.